HYDROGEOLOGICAL ASSESSMENT

LEVEL I AND II ASSESSMENT REPORT

PROPOSED AGGREGATE PIT (PIKE FARM)
PT LOT 18, CONCESSION 3, NRT
GEOGRAPHIC TOWNSHIP OF NORTH DORCHESTER
MUNICIPALITY OF THAMES CENTRE

LDS PROJECT NO. GE-00260

JANUARY 4, 2021

Submitted to:

THAMES VALLEY AGGREGATES

Distribution (via email):

Vito Frijia, Thames Valley Aggregates
vito@southsidegroup.ca

Table of Contents

Appendices

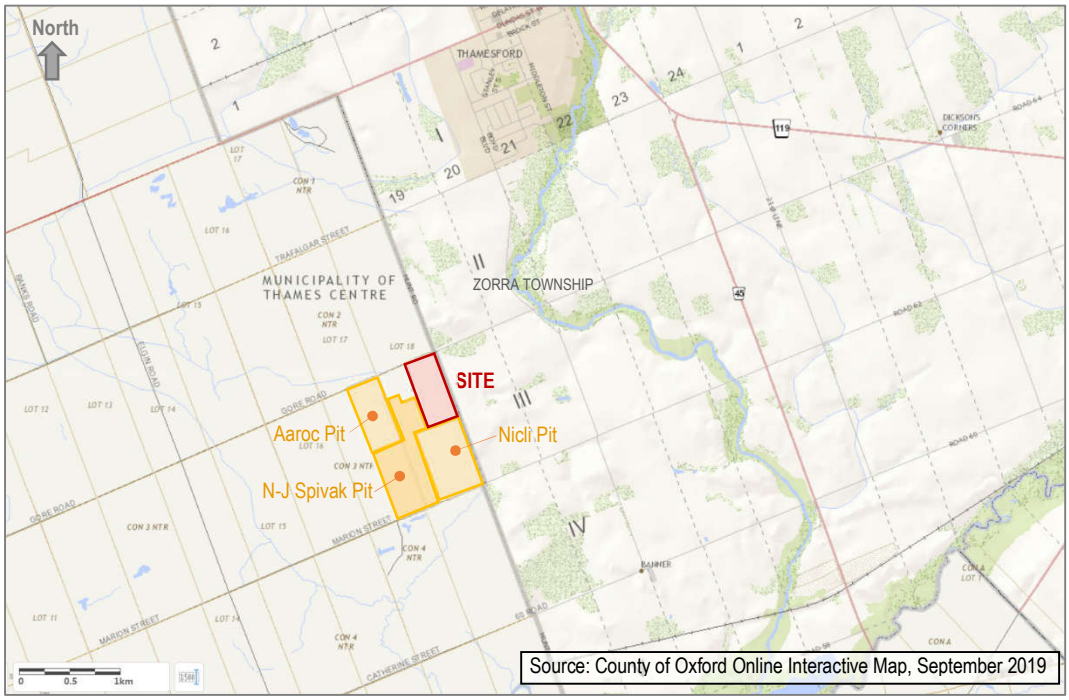
1. INTRODUCTION

LDS Consultants Inc. (LDS) has been retained by Thames Valley Aggregates to conduct a Hydrogeological Assessment for a proposed aggregate pit, located on the southwest corner of Hunt Road, and Gore Road, in the Municipality of Thames Centre, in Middlesex County. The legal description of the property is as follows:

- Part Lot 18, Concession 3 NRT
  Geographic Township of North Dorchester, Middlesex County

A Key Plan showing the site location is provided on Figure 1, below.

Figure 1: Key Plan



The subject lands are approximately 20.2 hectares in size. The neighbouring gravel pit operations which immediately border the property are also shown on Figure 1 (above), and operate under Class A Licenses. Additional gravel pit operations are also located within Thames Centre, within 1 km of the site.

The scope of work for the Hydrogeological Assessment was outlined in LDS' proposal (reference G2019-019, dated May 13, 2019). Authorization to carry out this work was received from Vito Frijia on behalf of Thames Valley Aggregates to proceed with the investigation and preparation of the report.

This Report has been prepared for the purposes of examining hydrogeological characteristics of the site. Based on the hydrogeological conditions, groundwater use in the area, the amount of collected field data, and subsequent interpretation, this report should be regarded as a Hydrogeological Level 1 and Level 2 Assessment.

According to the Ontario Provincial Standards, this report includes the requirements for Category 1, Class A license for a pit which intends to extract aggregate material from above and below the established groundwater table.

The Level 1 Hydrogeological Assessment included in this report provides a preliminary evaluation to determine the final extraction depth relative to the established groundwater table(s) and the potential for adverse effects to groundwater and surface water resources and their uses. As such, the following information has been incorporated into this report:

- Summary of borehole and shallow groundwater information based on drilling program and monitoring wells which have been installed at the site – monitoring commenced in July 2019, and continues on a monthly basis at the site;
- Characteristics of the shallow groundwater conditions, including stabilized water level, flow direction, gradient;
- Information compiled from a review of available publications and geological mapping for the area, including adjacent land uses, site topography, surface drainage and site features;
- Information compiled from a review of MECP Well Records, and supplemental data collected for the area through a well survey delivered to nearby properties;
- Discussion on potential adverse impacts which could result from the proposed gravel pit operation.

This report also includes the analyses associated with a Level 2 Hydrogeological Assessment, which expands on the discussion of potential adverse impacts, with discussion of mitigation measures and contingency measures to address potential concerns with contamination which could occur as a result of typical operations and aggregate extraction activities. Baseline groundwater chemistry has been documented with analytical testing on water samples collected from onsite monitoring wells.

This report is provided on the basis of the terms noted above, and is expected to form part of a submission to the Ministry of Natural Resources and Forestry (MNRF) to comply with the requirements of the Aggregate Resources Act.

The format and content of this report has been guided to address specific client needs. LDS has provided engineering guidelines for the geotechnical design and construction at the site. Laboratory testing, where applicable, follows ASTM or CSA Standards. The information in this report in no way reflects on the environmental aspects of the soil.

2. SITE PHYSICAL FEATURES

2.1 Site Location and Description

The subject property is located on the southwest corner of Hunt Road, and Gore Road, in the Municipality of Thames Centre, in Middlesex County. The site is rectangular in shape, and comprises an area of approximately 20.2 hectares. A 60 m wide band of trees are located along the northern edge of the property, bordering Gore Road.

A small wooded area (approximately 100 m by 100 m in size) is located in the southwest corner of the site. The remainder of the site is occupied with agricultural lands used for cultivating. There are no existing buildings or structures at the property. Select Site Photographs are provided in Appendix A, for reference.

2.2 Topography and Surface Drainage

The site topography is gently rolling throughout, with a topographic relief of approximately 5 m across the site, ranging from Elevation 275 to 280 m above sea level (ASL). This is consistent with the Topographic Map for the area (which is provided on Drawing 1, in Appendix A), and reports the ground surface elevation at Elevation 280 m ASL.

The ground surface elevation along the north side of the site sits below Gore Road. Surface water drainage along Gore Road flows through a drainage ditch, along the south side of the road. Similarly, a drainage ditch follows the west side of Hunt Road.

Norsworthy Municipal Drain is located along the north side of Road 64, and conveys flows which flows westward for just over 2 kilometres before discharging into the Caddy Creek Municipal Drain east of Elgin Road. Leslie Municipal Drain is located to the south, at the intersection of Hunt Road and Marion Street, south of the Nicli Pit, approximately 700 m south of the southeast corner of the site.

Surface drainage enters the north part of the site (northern woodlot, described in Section 2.3) via a 525 mm wide corrugated plastic culvert at Hunt Road, flows diffusely westward through the central part of the northern woodlot, and exits the site via a second corrugated plastic culvert beneath Gore Road. This drainage is not mapped as a distinct surface water drainage feature within publicly-available aquatic resource or watercourse mapping available from Upper Thames Region Conservation Authority (UTRCA) or through the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). Following conveyance northward beneath Gore Road, the drainage enters the Norsworthy Drain.

There is open water within the gravel pit lands to the south of the property, associated with the aggregate extraction within those lands.

Observations at the site did not identify any significant surface erosion or swales, which generally indicate that stormwater run-off tends to sheet flow off the site, or is absorbed into the surficial soils.

The Thames River is located approximately 1.1 km east of the northeast corner of the site. Caddy Creek is located approximately 2 km west of the site. A tributary drain extends along the north side of Gore Road, north of the site limits.

2.3 Natural Heritage Features

As noted in Section 2.1, two wooded areas are present at the site, one along the northern site boundary which is approximately 60 m long along the length of the site; the second, a small wooded area in the southwest corner of the site, approximately 100 m by 100 m in size.

Based on the Natural Environment Report prepared by Terrastory Environmental Consulting Inc. (Terrastory), it is understood that the northern woodlot contains a variety of upland and wetland vegetation communities – including a deciduous swamp and meadow marsh in the central part of the woodlot, and upland forest/woodland communities on either side of the wetland area.

The wetland area receives base flow contributions from surface water conveyed from offsite wetlands to the east, through a culvert which extends below Hunt Road. It is understood that the wetland area experiences seasonally dry periods, as documented in Terrastory's Report. The ground surface elevation of the western portions of the deciduous swamp appear to be at or slightly below the elevation of BH1. Based on seasonal high groundwater levels recorded in the monitoring well at this location, it is anticipated that under seasonal conditions, that a portion of the wetland may be supported by shallow groundwater under seasonal conditions, in addition to the surface water inputs noted above.

The Topographic Plan provided on Drawing 1 and the aerial photographs provided on Drawing 2, shows the lands on the north side of Gore Road being occupied with a wetland feature. It is understood that the wetland area north of Gore Road is identified as a Provincially Significant Wetland.

No other natural heritage features were noted onsite.

2.4 Adjacent Land Use

The lands immediately south of the property are occupied by a 32-hectare gravel pit operation, owned by Nicli Aggregates, with a maximum annual tonnage of 500,000. South and west of the site, N-J Spivak Ltd operates a 42-hectare gravel pit, which has a maximum annual tonnage of 227,000. West of the N-J Spivak operation, Aaroc Aggregates operates a 21-hectare gravel pit with a maximum annual tonnage of 250,000. The neighbouring gravel pit operations which immediately border the property are shown on Figure 1 (Section 1) and on Drawing 1, in Appendix A.

To the east of Hunt Road, the lands are agricultural, and support a dairy operation and are used for agricultural cultivation.

2.5 Extraction Plan

Overall extraction details are outlined below, and are denoted on the Project Drawings prepared by Harrington McAvan Ltd.:

- Total area to be licensed – 21.0 hectares
- Total area to be extracted and rehabilitated – 16.30 hectares
- Maximum tonnage to be removed – 500,000 tonnes per year

The small wooded parcel at the southwest corner of the site is expected to be removed as part of the site preparation works. Extraction is expected to be carried out from south to north across the site, using conventional construction equipment, including trucks, loaders, excavators, backhoes, bulldozers, scrapers, and conveyors. Portable processing equipment will be utilized at the site, and the location will be shifted to accommodate the aggregate extraction operation. It is understood that existing vegetation within the licensed area will be maintained under sequential stripping begins or until the rehabilitation is completed.

The northern extent of the extraction limit is expected to be set at the greater setback limit of either 15 m from the woodland dripline or 30 m from the wetland which is contained within the northern woodlot.

The primary site access will be located at the northeast corner of the site, south of the existing woodlot, and the primary truck route will be located along the easterly limit of the site. Drawing 3 (in Appendix A) shows the various operation stages which denote the extraction zones for each phase of the project, and the site rehabilitation plan which denotes the presence of a pond at completion. The finished pond area is expected to be about 11.33 hectares in size, at completion.

The rehabilitation plan also identifies a reforestation area of approximately 0.76 ha, within the northern part of the site to compensate for the wooded area at the south end of the property which is expected to be removed.

3. STUDY METHODOLOGY

3.1 Review of Geologic Mapping

Physiography & Quaternary Geology

In Southwestern Ontario, the last continental scale glaciation was during the Wisconsinan Time. The glaciers extended south of Southwestern Ontario. When the glaciers began to retreat during the Late Wisconsinan, this resulted in the deposition of material contained in the glaciers. Lakes, rivers, and spillways created by the meltwater from the retreating glaciers deposited massive amounts of glacial debris and shaped the landscape of Southwestern Ontario.

Physiographic mapping for Southwestern Ontario *(Chapman, L.J. and Putnam, D.F. 2007. Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release-Data 228)*, identifies that the site is located within the physiographic region known as the Oxford Till Plain, and is set in an undrumlinized till plain. Soil conditions are expected to be comprised of silt till soils and sand and gravel deposits.

Quaternary geology mapping for the Zorra area *(Quaternary Geology, Ontario Geological Survey Map P1048, Lucan Area, Scale 1:50,000, 1975)* indicates that the study area consists of ice-contact stratified drift deposits of silt with some sand and gravel in the north half of the site, and ice-contact gravel deposits with some re-worked glacial till in the south part of the site. This is demonstrated on Drawing 4, in Appendix A.

The Quaternary geology mapping also shows the site being located along the eastern side of the Dorchester moraine, which was formed at the most northward advance of the Erie Lobe. The Dorchester moraine is comprised of sandy drift till identified as Catfish Creek Till. Catfish Creek Till is associated with the Nissouri Stadial period, and is typically characterized of several layers of subglacial till and stratified sediments of glaciofluvial or glaciolacustrine origin.

Bedrock Geology

Bedrock geology mapping for Southwestern Ontario *(Ontario Geological Survey. 1:250 000 scale, Bedrock Geology of Ontario. Ontario Geological Survey, Miscellaneous Release Data 126, Revised 2006)* indicates that bedrock in the general area consists of limestone, dolostone and shale from the Dundee formation, from the Middle Devonian Period. Geological publications describe the limestone as grey – brown medium to thickly bedded limestone and dolostone, containing fossils, bituminous partings and microstylolites.

Bedrock was not encountered during the fieldwork for this investigation, but is expected to be at approximately Elevation 250-260 m (~25 m depth), based on the following Bedrock Topography mapping: *Bedrock Topography of the Lucan Area, Southern Ontario, Ontario Geological Survey, Preliminary Map P291, scale 1:50,000, 1980 compilation.* This is documented on Drawing 4, in Appendix A.

3.2 MECP Well Record Review

A review of local well records available through the Ministry of Environment, Conservation, and Parks (MECP) for this area was carried out to review the water levels recorded in the nearby wells. Drawing 9 in Appendix A shows the location of the wells (with corresponding Well Registration No.) which are in close proximity (within 500 m) of the site.

Table 1: MECP Well Record Summary

MECP Well ID	Completion Date	Depth (m)	Water Found (m)	Static Level (m)	Pump Rate (L/min)	Northing (m N)	Easting (m E)
Water Supply Wells							
4105642	1971-10-28	26.5	7.6	9.1	38.0	4763593.0	498383.7
4704458	1976-09-02	20.1	11.6	10.4	38.0	4763443.0	499313.7
7192459*	2012-11-02	*22.2*	*NR*	10.3	102.6	4763441.0	499330.0
Observation / Test Holes							
4102842	1955-05-06	24.7	*NR*	*NR*	*NR*	4763653.0	498403.7
4102844	1955-05-19	27.1	*NR*	*NR*	*NR*	4763963.0	498523.7
7339805	2019-07-22	Well Cluster – LDS monitoring wells for current assessment					
Abandoned – Water Supply							
4104822	1969-10-15	11.6	8.2	8.2	15.2	4763543.0	498673.7

**Well Record 7192459 is for a 2.1 m extension installed on Well #4704458.*

One active shallow water supply well is noted in the above table. The shallow well was located at the residence on the north side of Road 64, about 300 m west of the site. The shallow groundwater in this well, appears to be sourced from the shallow water-bearing sand soils encountered in the boreholes and monitoring wells drilled at the site.

The remainder of the water supply wells are set into the intermediate overburden aquifers contained within sand and gravel soils. Pump rates indicate strong yield capacities in the shallow and intermediate depth overburden aquifers, and in the bedrock aquifer.

A well survey was delivered to nearby properties in an effort to validate the information available in the MECP well records. Additional information is provided in this regard, in Section 3.7.

3.3 Source Water Protection Mapping

Where proposed developments are being planned, it is important to determine the presence of Significant Groundwater Recharge Areas and High Vulnerability Aquifers in the area. These areas are protected under the Clean Water Act (2006). In general, Significant Groundwater Recharge Areas are defined as areas where water seeps into an aquifer from rain and melting snow, supplying water to the underlying aquifer. A highly vulnerable aquifer occurs where the subsurface material offers limited protection from contamination resulting from surface activities.

The Thames-Sydenham and Region Source Protection Plan (approved September 2015) presents the framework for assessing lands within the City of London and surrounding area. The Source Protection Plan also presents the assessment work which has been done by the Thames-Sydenham and Region Source Protection Committee.

A more detailed discussion is provided below.

Significant Groundwater Recharge Areas (SGRA)

Groundwater recharge is largely controlled by soil conditions, and typically occurs in upland areas. As discussed previously, regional groundwater flow directions identified in the Middlesex-Elgin Groundwater Study for overburden and bedrock aquifers are typically indicated to be in a southerly or westerly direction.

As defined in the Clean Water Act (2006), an area is a significant groundwater recharge area if,

- the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or,
- the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.

The Thames-Sydenham and Region Source Protection Committee has prepared an assessment report for the Upper Thames River Source Protection Area. As defined by the Clean Water Act (2006) and identified by the Thames-Sydenham and Region Source Protection Committee, the south-eastern portion of site is located within a Significant Groundwater Recharge Area (SGRA) with a Vulnerability rating of 2, as demonstrated on Drawing 10 in Appendix A. Vulnerability of SGRA's is determined by cross referencing aquifer vulnerability maps with SGRA mapping. Those areas which have high intrinsic vulnerability are classified as 6, and those with low vulnerability as 4 and 2. It should be noted that the site is **not** included in the SGRA.

High Vulnerability Aquifers

The susceptibility of an aquifer to contamination is a function of the susceptibility of its recharge area to the infiltration of contaminants.

In the Thames-Sydenham and Region, HVA’s were mapped using the Intrinsic susceptibility index (ISI) method, which is an indexing approach using existing provincial Water Well Information System (WWIS) database. The ISI method is described in detail in the MOE’s Technical Terms of Reference (2001), and is an empirical scoring system that takes into consideration the unique hydrogeologic conditions at a particular location.

The scores are determined using a combination of the saturated thickness of each unit and an index number related to the soil type, and as such, the scores reflect the susceptibility of the aquifer to contamination. As defined in the MOE's 2008 Technical Rules:

- Low Vulnerability – ISI score greater than 80
- Medium Vulnerability – ISI score of 30 to 80
- High Vulnerability – ISI score less than 30

Using the method described above, the Thames-Sydenham and Region Source Protection Committee has determined, that the Site is **not** within highly vulnerable aquifer zone.

Wellhead Protection Area

The Thames-Sydenham and Region Source Protection Report outlines that Wellhead Protection Areas (WHPA's) are defined as the vulnerable areas around groundwater sources that have been delineated using three-dimensional groundwater flow models. The WHPA for each well field (or well) is based on an estimate of the groundwater travel time to the well, with defined zones extending out to a period of 25-years for groundwater travel to the well.

Based on the aforementioned Report, the subject lands are **not** within or near a WHPA.

Summary Comments

Although the previous discussion identifies that the site is not situated within an area of concern related to Source Water protection concerns, the site development should still have regard for the sensitivity of the shallow aquifer, and operations associated with the aggregate extraction operations should incorporate suitable measures to minimize negative effects to the shallow groundwater aquifer. This can be addressed through the use of best-management practices for equipment maintenance and fuelling activities, incorporating contingency and mitigation measures into operational plans, and effective monitoring.

3.4 Field Program

LDS carried out a field program consisting of a series of seven boreholes, drilled between July 10 and 22, 2019. The boreholes were advanced at the site by a local drilling-contractor, using a track-mounted drill-rig. The boreholes (denoted as BH1 through BH7) were advanced to depths ranging from 3.5 to 11.1 m (11.5 to 36.5 feet) below existing grade.

Ground surface elevations at the borehole locations were surveyed by LDS using a Trimble R10 GPS rover. The location of the boreholes is summarized in Table 2, and illustrated on Drawing 5, in Appendix A.

Table 2: Borehole Locations

Location	Northing, m N	Easting, m E	Ground Surface Elevation (m asl)
BH 1 (MW)	4763648.538	498827.222	275.256
BH 2 (MW)	4763697.658	499125.391	276.442
BH 3	4763562.324	499062.029	277.674
BH 4 (MW)	4763408.326	498917.724	277.866
BH 5 (MW)	4763363.492	499256.096	280.899
BH 6 (MW)	4763125.449	499138.749	279.946
BH 7 (MW)	4763187.026	499297.877	281.124

Monitoring wells were installed in all of the boreholes, with the exception of Borehole BH3, to allow for monitoring the stabilized groundwater level at the site. The wells are comprised of 50 mm diameter CPVC pipes with slotted and filtered screens. Details of monitoring well construction are provided on the borehole logs in Appendix B, and summarized in the table below. The monitoring wells have been registered with the Ministry of Environment, Conservation, and Parks (MECP), in accordance with Ontario Regulation (O.Reg.) 903.

Table 3: Monitoring Well Installation Details

Location	Ground Surface Elevation (m asl)	Well Installation Depth, m	Screened Length, m	Screened Strata
BH 1 (MW)	275.256	3.1	1.5	Silty Sand / Sandy Silt
BH 2 (MW)	276.442	3.1	1.5	Fine Sand, trace Silt
BH 4 (MW)	277.866	6.6	1.5	Sand, some Gravel
BH 5 (MW)	280.899	10.7	1.5	Silty Sand and Gravel
BH 6 (MW)	279.946	10.7	1.5	Fine to Medium Sand, trace Silt
BH 7 (MW)	281.124	10.7	1.5	Fine Sand, some Silt

Within Borehole BH3, the borehole was examined for signs of groundwater seepage prior to backfilling. The borehole was backfilled with a mixture of bentonite chips and cuttings, to restore the backhoe back to level conditions with the ground surface.

A monitoring program has been carried out to record the groundwater conditions from July 2019 to present. A submersible pressure transducer with a data logger (Onset Hobo U20L unit) was installed at boreholes BH2, BH5 and BH6 to provide a continuous set of water level measurements at the site. Pressure corrections for changes in barometric pressure have been applied to the continuous water level measurements, based information from the Environment Canada Weather Station at London International Airport.

The fieldwork was supervised by members of LDS' technical staff. All samples recovered from the site were returned to LDS for detailed examination and selective testing. Collected samples will be disposed of, following the issuance of the Hydrogeological Report, unless prior arrangements have been made for longer term storage.

3.5 Laboratory Testing – Soils

All samples recovered from the site were returned to LDS for detailed examination and selective testing. Select samples were collected from the boreholes for further review and laboratory testing.

Six grain size analyses were carried out on select samples of the predominant subgrade soils, where shallow groundwater conditions were identified. Routine moisture content determinations were also carried out on select samples from each borehole.

Collected samples will be disposed of, following the issuance of the Hydrogeological Report, unless prior arrangements have been made for longer term storage.

3.6 Laboratory Testing – Water Quality

Groundwater samples were collected from select boreholes at the site on September 20, 2019. The monitoring wells at BH2 and BH6 were developed 24 hours in advance of the testing, including the removal of the equivalent of three water-columns of water. The water samples were collected using designated bailer tubes.

The laboratory was contacted in advance to order sufficient soil and groundwater pre-cleaned (and pre-preserved, where applicable) sample containers for the desired analyses, pre-labelled with the LDS project number and project location.

All water samples collected at the site were secured and transported to Maxxam Analytics in designated lab-supplies containers, and stored in a chilled cooler for transport. The water samples were submitted for general chemistry analyses, which included pH, inorganics and dissolved metals, as well as calculated parameters for anion and cation summaries, hardness and total dissolved solids.

The Certificate of Analysis provided by the laboratory is provided in Appendix C, along with piper diagrams which provide a graphical representation of the cations and anions on ternary plots.

3.7 Well Survey

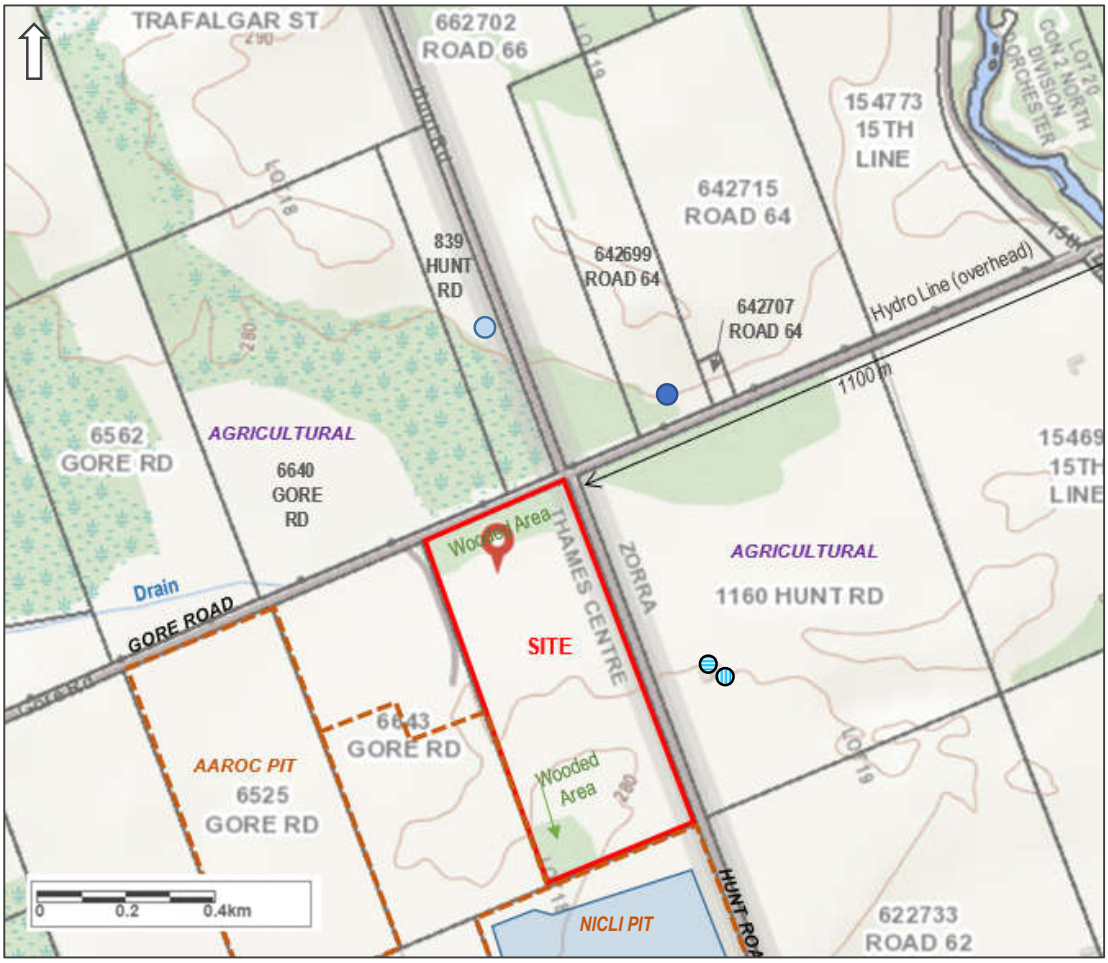
A well survey questionnaire was delivered to the neighbouring properties in an effort to validate the information about water supply wells in the area which is available in the MECP well records. A copy of the covering letter and questionnaire are provided in Appendix F, along with the responses which were received by LDS. Two copies of the covering letter and questionnaire were delivered (in August and September 2019), and included return options via mail, email, or to phone LDS directly to relay the information.

Responses which were received are summarized in Table 4.

Table 4: Well Survey Summary

Address	Well Type	Static Water Level	Water Quality	Comments
839 Hunt Road, Dorchester	18.5 ft depth	16 ft depth	No issues reported	Well used as domestic water supply Water treatment units include water softener and UV screen Unknown age of well Approx. Location denoted with ○ in Figure 2
1160 Hunt Road, Ingersoll	Well 1 - Drilled 65 ft depth	Not reported	No issues reported	Well used as domestic water supply and for dairy farm operations Iron filter at house Corresponds with MECP Well No. 4704458 Approx. Location denoted with ⊖ in Figure 2
1160 Hunt Road, Ingersoll	Well 2 - Drilled, 250 ft depth	Not reported	No issues reported	Well used for agricultural use – cattle Reportedly contains high sulphur content Approx. Location denoted with ◍ in Figure 2
642699 Road 64, Ingersoll	Drilled, 180 ft depth	15-20 ft depth	No issues reported	Well used as domestic water supply No water treatment units Estimated drill date in late 1980s / early 1990s Approx. Location denoted with ● in Figure 2

Figure 2: Well Survey Response Locations



The well located at 839 Hunt Road is reportedly a shallow overburden well, which is not identified in the MECP well records. The well is located approximately 300 m north of the northern site limit, and on the north side of the wetland area which is north of Gore Road.

The two wells located at 1160 Hunt Road are approximately 100 m east of the site, and the shallower of the two wells correspondence with MECP Well No. 4704458. The deeper well does not appear to be included in the well records, based on the reported depth. Based on the overall depth of these two wells, adverse impacts to the water supply are not anticipated, since they are set well below the anticipated excavation depths associated with aggregate extraction at the site.

The deep drilled well located at 642699 Road 64 is located approximately 300 m northeast of the northeast limits of the site, and is also not included in the MECP well records. Based on the overall depth of the well, adverse impacts to the water supply for this well is not anticipated, since it is set well below the anticipated excavation depths associated with aggregate extraction at the site.

4. BOREHOLE FINDINGS

4.1 Soil Conditions

A series of seven boreholes were advanced at the site to examine soil and shallow groundwater conditions. The borehole locations are shown on Drawing 5, in Appendix A. In general, soils observed in the boreholes consisted of topsoil overlying silt, sand and/or sand and gravel soils, which in turn overlie natural silt till soils. General descriptions of subsurface conditions are summarized in the following sections. Borehole logs are provided in Appendix B, for reference.

It should be noted that boundaries of soil indicated in the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

Topsoil

Each borehole was surfaced with a layer of topsoil. The topsoil consisted of brown sandy loam, and the thickness ranging from 450 to 600 mm across the site. The topsoil was in a damp to moist state at the time of the fieldwork, based on visual and tactile examination. Some mixed soil was observed in the underlying subgrade soils, likely as a result of the cultivation of the field.

Silt

A near surface layer of silt was encountered below the topsoil in borehole BH 1. The silt was approximately 1.0 m thick, and generally described as brown in colour, and in a weathered condition, containing trace amounts of sand. The silt is generally noted to be in a compact state, based on augering resistance.

Sand / Silty Sand

Sand or Silty Sand was contacted in each of the boreholes, with the exception of borehole BH3. The sand was found to have a variable texture, ranging from silty sand, to sand with some silt and some gravel. The sandy soils were generally found to be in a compact to dense state, based on auger resistance, and Standard Penetration Test (SPT) blow counts in the range of 17 to 32 blows per 0.3 m penetration of the split-spoon sampler. Five samples were submitted for gradation analyses. The results of the grain size analyses are provided graphically in Appendix B, and are summarized below, in the following table.

Table 5: Sand / Silty Sand Gradation Results

Sample ID	% Gravel	% Sand	% Fines (Silt and Clay)
BH1, SA 3 – Silty Sand / Sandy Silt	0.0	44.4	55.6
BH2, SA 4 – Fine Sand, trace silt	0.0	88.7	10.9
BH4, SA 6 – Sand, some Gravel	19.5	77.1	3.4
BH6, SA 8 - Fine to Medium Sand, trace Silt	0.1	91.6	8.3
BH7, SA 9 – Fine Sand, some silt	0.0	83.8	16.2

In-situ moisture contents within the sandy soils were generally found to be in the range of 3 to 8 percent above the stabilized groundwater table, and in the range of 10 to 26 percent within the saturated soils.

Sand and Gravel

The predominant soils encountered in the boreholes comprise of sand, and sand and gravel soils. These soils were observed to be well graded, and were observed to contain occasional cobbles, based on augering resistance. The sand and gravel soils were generally found to be in a compact to dense state.

For the purposes of characterising the soil permeability, a sample was submitted for gradation analysis. The results of the grain size analysis is provided graphically in Appendix B, and summarized below.

Table 6: Sand and Gravel Gradation Results

Sample ID	% Gravel	% Sand	% Fines (Silt and Clay)
BH5 – Silty Sand and Gravel	26.8	51.9	21.3

Silt Till

A layer of silt till was encountered immediately below the topsoil in borehole BH3, and at the base of boreholes BH 1 and 4. The silt till generally contained trace sand, trace to some fine gravel. The silt till is in a dense to very dense state. Moisture content determinations conducted on recovered samples of the till generally range between 17 percent, generally indicative of moist soil conditions. The silt till was observed to contain intermittent when sand seams within borehole BH1.

4.2 Soil Permeability

The hydraulic conductivity of a soil depends on a number of factors, including particle size distribution, degree of saturation, compactness, adsorbed water (which depends on clay content). The heterogeneous nature of glacial deposits can also contribute to variations in soil permeability where the soil composition may include localized areas with increased fine material or sandy material which can influence soil permeability at different points within the soil strata.

Grain Size analyses were carried out on select samples of the sand, and sand and gravel soils encountered at the site. The results of the testing are provided below for reference, and shown graphically in Appendix B. In addition to the soil composition outlined below, the following table also provides a saturated hydraulic conductivity and factored infiltration rate, based on the gradation results for each sample. The results of the grain size analyses were used to correlate the gradation results to the hydraulic conductivity, using Hazen's method. This correlation is based on the following relationship:

$$k\ (cm/s) = C(d_{10})^2$$

where, d_{10} is the diameter (size measured in mm) at which 10% of the sample passes; and,
C is an empirical coefficient (average value of 1.0).

Table 7: Saturated Hydraulic Conductivity

Sample ID	Gradation Results			Saturated Hydraulic Conductivity (m/s)
	Fines (% Silt & Clay)	% Sand	% Gravel	
BH1, SA 3 – Silty Sand / Sandy Silt	55.6	44.4	0.0	4.84×10^{-6}
BH2, SA 4 – Fine Sand, trace silt	10.9	88.7	0.0	4.23×10^{-5}
BH4, SA 6 – Sand, some Gravel	3.4	77.1	19.5	9.00×10^{-4}
BH5 – Silty Sand and Gravel	21.3	51.9	26.8	9.61×10^{-4}
BH6, SA 8 – Well Graded Sand, trace Silt	8.3	91.6	0.1	6.40×10^{-5}
BH7, SA 9 – Fine Sand, some silt	16.2	83.8	0.0	2.50×10^{-5}

4.3 Cross Sections

Two geologic cross sections have been created for the site, with the cross-section locations shown on Drawing 5, and the cross sections presented on Drawing 6, in Appendix A. Results of the onsite drilling indicates that a surficial topsoil layer covers much of the Site, which in turn is underlain by discontinuous deposits of silt, sand and/or sand and gravel. A lower silt till layer was identified at the bottom of some of the boreholes, which extend to the termination depth of the boreholes.

5. HYDROGEOLOGICAL SETTING

5.1 Regional Setting

Within the broad, regional setting, three aquifers have been identified, and are characterized below:

- Shallow unconfined overburden aquifer, typically contained within surficial deposits of sandy soils, generally encountered at relatively shallow depth;
- Intermediate confined overburden aquifer, typically contained within outwash sand and gravel soils which are generally set between glacial till soils; and,
- Bedrock aquifer contained within the shale or limestone bedrock.

For the purposes of this study, the focus is on the shallow unconfined aquifer, contacted in the boreholes and monitoring wells installed at the site. This shallow aquifer is also identified as being a high vulnerability aquifer, susceptible to impacts from surface and near surface activities.

The regional predominant groundwater flow direction within the shallow aquifer is generally expected to follow the surface topography, with water flow towards the Thames River, located to the east /southeast from the site. However, tributary creeks and streams which outlet to the Thames River, and artificially created surface water features in the area are also expected to influence the shallow groundwater flow direction.

In general, source water for the shallow overburden aquifer is relatively local, being precipitation falling on nearby Lots and Concessions and possibly on a Township scale. Local topography will define the source area for the unconfined shallow aquifer.

5.2 Shallow Groundwater Conditions

The wells installed into the LDS boreholes were advanced using 6-inch (152.4 mm) outer diameter hollow stem augers. The monitoring wells were constructed with 2-inch (50.8 mm) diameter CPVC pipe. The screens on each well are mill-slotted, with a slot spacing of 0.5 mm, and were backfilled with Type 2 Silica Sand. Above the screened depth, the annular space was backfilled with a Bentonite slurry, up to ground surface.

The following sections outline the short term and stabilized groundwater measurements recorded at the site.

5.2.1 Manual Groundwater Measurements

Short term water level observations were recorded from the open boreholes and newly installed monitoring wells at the time of installation. Groundwater observations in the open boreholes and a review of soil moisture contents are indicative of the shallow groundwater generally being contained within the sand and gravel soils. Short term water levels are summarized in Table 8..

Table 8: Short Term Groundwater Measurements

Borehole	Ground Surface Elevation, m bgs	Groundwater Observations	Groundwater Elevation, m asl
BH1 (MW)	275.26	Water measured at 1.8 m	273.46
BH2 (MW)	276.44	Water measured at 1.3 m	275.14
BH3	277.67	Open and dry at completion of drilling	N/A
BH4 (MW)	277.87	Water measured at 5.6 m	272.27
BH 5 (MW)	280.90	Water measured at 9.8 m	271.10
BH6 (MW)	279.95	Water measured at 9.0 m	270.95
BH 7 (MW)	281.12	Water measured at 9.0 m	272.12

Stabilized groundwater levels were measured at the site from July 2019 to present on a monthly basis, as shown in Table 9. For design purposes, it is recommended that the manual water level measurements from March 2020 be used as a reasonable representation of the seasonal high groundwater condition at the site.

As demonstrated by the manual groundwater level measurements recorded at the site, the shallow groundwater will vary in response to climatic or seasonal conditions, with the highest levels possible in wet seasons, particularly under spring conditions.

The shallowest groundwater levels were encountered in Boreholes BH1 and BH2, which are located in the north end of the site. Boreholes BH1, BH2 and BH4, which are located in the north half of the site demonstrate the most fluctuation in the stabilized groundwater levels, with total fluctuations ranging from 1.40 to 3.48 m. Borehole BH5, BH6 and BH7, which are located in the south half of the site demonstrate the least seasonal fluctuation, with groundwater.

Table 9: Manual Water Level Measurements

Location	Ground Surface Elev. (m)	Depth to Groundwater (m, bgs) *Groundwater Elevation (m, asl)*																
		July 22, 2019	Aug 08, 2019	Sep 04, 2019	Oct 24, 2019	Nov 07, 2019	Dec 02, 2019	Jan 06, 2020	Feb 11, 2020	March 05, 2020	April 03, 2020	May 28, 2020	June 12, 2020	July 14, 2020	Aug 24, 2020	Sep 21, 2020	Oct 14, 2020	Nov 19, 2020	Dec 14, 2020
BH 1	275.26	1.53 *273.73*	1.91 *273.35*	2.06 *273.20*	2.29 *272.97*	2.07 *273.19*	2.12 *273.14*	1.12 *274.14*	0.22 *275.04*	0.15 *275.11*	0.40 *274.86*	1.00 *274.26*	1.23 *274.03*	1.76 *273.50*	2.14 *273.12*	2.24 *273.02*	2.30 *272.96*	2.20 *273.06*	2.02 *273.24*
BH2	276.44	0.59 *275.85*	1.37 *275.07*	1.65 *274.79*	1.30 *275.14*	0.49 *275.95*	0.37 *276.07*	0.30 *276.14*	0.30 *276.14*	0.25 *276.19*	0.35 *276.09*	0.64 *275.80*	0.65 *275.79*	1.56 *274.88*	1.68 *274.76*	1.48 *274.96*	1.28 *275.16*	*0.64* *275.80*	*0.27* *276.17*
BH4	277.87	5.26 *272.61*	5.61 *272.26*	6.00 *271.87*	6.50 *271.37*	6.14 *271.73*	6.81 *271.06*	5.91 *271.96*	3.33 *274.54*	4.10 *273.77*	3.85 *274.02*	4.37 *273.50*	4.81 *273.06*	5.45 *272.42*	6.10 *271.77*	6.20 *271.67*	6.44 *271.43*	*6.45* *271.42*	*6.28* *271.59*
BH5	280.90	9.75 *271.15*	9.82 *271.08*	9.96 *270.94*	10.29 *270.61*	10.14 *270.76*	10.20 *270.70*	10.07 *270.83*	9.68 *271.22*	9.69 *271.21*	9.60 *271.30*	9.73 *271.17*	9.81 *271.09*	9.96 *270.94*	10.12 *270.78*	10.20 *270.70*	10.26 *270.64*	*10.30* *270.60*	*10.32* *270.58*
BH6	279.95	8.88 *271.07*	9.00 *270.95*	9.11 *270.84*	9.23 *270.72*	9.16 *270.79*	9.20 *270.75*	9.15 *270.80*	8.86 *271.09*	8.61 *271.34*	8.69 *271.26*	8.86 *271.09*	8.91 *271.04*	9.07 *270.88*	9.19 *270.76*	9.25 *270.70*	9.30 *270.65*	9.33 *270.62*	9.31 *270.64*
BH7	281.12	9.92 *271.20*	10.09 *271.03*	10.23 *270.89*	10.30 *270.82*	10.28 *270.84*	10.33 *270.79*	10.28 *270.84*	9.96 *271.16*	9.90 *271.22*	9.86 *271.26*	9.93 *271.19*	10.04 *271.08*	10.17 *270.95*	10.33 *270.79*	10.34 *270.78*	10.40 *270.72*	10.44 *270.68*	10.43 *270.69*

Table 10: Seasonal Fluctuations in Stabilized Water Levels

Location	Ground Surface Elev. (m)	Depth to Groundwater (m, bgs) *Groundwater Elevation (m, asl)*		Total Fluctuation (m)
		High Water Levels	Low Water Levels	
BH 1	275.26	0.15 *275.11*	2.29 *272.97*	2.14
BH2	276.44	0.25 *276.19*	1.68 *274.76*	1.43
BH4	277.87	3.33 *274.54*	6.81 *271.06*	3.48
BH5	280.90	9.60 *271.30*	10.29 *270.61*	0.69
BH6	279.95	8.61 *271.34*	9.33 *270.62*	0.72
BH7	281.12	9.86 *271.26*	10.44 *270.68*	0.58

5.2.2 Continuous Groundwater Measurements – LDS Datalogger Installations

Dataloggers were installed in monitoring wells installed at boreholes BH2, BH5 and BH6, to allow for regular continuous temperature and water level readings. The data loggers have been downloaded on a regular basis, with manual groundwater measurements collected to confirm the accuracy of the data collected by the dataloggers. Groundwater Hydrographs are provided in Appendix D, for reference.

Hydrographs also include water temperatures recorded in the monitoring wells with the dataloggers. The hydrographs include precipitation data, and indicate that water levels within the shallow boreholes (BH2) are significantly influenced by precipitation events and seasonal conditions. The hydrographs in the deeper boreholes (BH5 and BH6) appear less responsive to rain events.

These findings are not surprising, given that the presence of a confining layer is at a much shallower depth in the north end of the site, where the shallow boreholes are located. The finer grained soils and unconfined aquifer in this part of the site has less vertical capacity to absorb water infiltrated from rain events, without altering the stabilized water level. Whereas in the deeper wells, the deeper underlying confining layer and the more permeable sand, and sand and gravel soils can more readily accommodate the addition of infiltrated surface water.

5.3 Groundwater Flow Direction and Hydraulic Gradients

The groundwater flow direction interpreted from the water level measurements collected by LDS indicates groundwater flow in a southerly direction, towards the open water on the adjacent lands. This is demonstrated on the Groundwater Contour Plans provided on Drawings 7 and 8 in Appendix A, which shows the groundwater contours and general flow direction, based on the manual groundwater measurements recorded at the site in the fall of 2019 and spring of 2020. Monitoring wells are being maintained for the purposed of collecting seasonal groundwater measurements. It is noteworthy to mention that the spring and summer groundwater contour plans demonstrate some seasonality on the shallow groundwater flow direction and with the overall depth of the shallow groundwater, with summer water levels being approximately 0.3 to 0.6 m lower in summer conditions. Groundwater gradients under spring and summer conditions are summarized below:

Table 11: Hydraulic Gradient

Seasonal Condition	Gradient, m/m		
	Maximum [1, 2]	Minimum [1, 3]	Average [4]
Fall Conditions – September 2019	0.021	0.004	0.011
Spring Conditions – March 2020	0.021	0.007	0.014

Notes:

1. Maximum and minimum gradients determined from groundwater contours, as shown on Drawings 7 and 8.
2. Maximum gradient measured along east property limit, in central part of the site.
3. Minimum gradient measured along the west property limit, in central part of the site.
4. Average gradient determined using water levels at monitoring wells BH/MW2 and BH/MW5.

The relatively small change groundwater elevation in the south end of the Site is attributed to the presence of pond on the lands to the south, and the relatively high permeability sand and gravel deposits. Sand and gravel deposits are highly transmissive and therefore do not support high hydraulic gradients. In the north and central part of the Site groundwater flow occurs within the finer grained silty sand and sandy silt soils. The fine sand and silt deposits have lower transmissivity and groundwater contours are spaced closer together indicating higher horizontal hydraulic gradients.

5.4 Groundwater Chemistry

Groundwater samples were collected from select boreholes at the site on September 20, 2019. The rationale for selecting the sampling locations was that one sample (taken from BH2) was at the north end of the site, close the wooded area and Hunt Road, and another sample (taken from BH6) was at the south end of the site, closest to the open water on the adjacent property.

The monitoring wells at BH2 and BH6 were developed 24 hours in advance of the testing, including the removal of the equivalent of three water-columns of water. The water samples were collected using designated bailer tubes. Each well was fitted with a dedicated bailer to allow purging and sampling of the well and avoid cross-contamination. The monitoring well and piezometer were purged of at least 3 times the volume of water prior to sampling.

The analytical testing included the following sampling parameters.

- Nutrients: Nitrate, Nitrite, total ammonia;
- Dissolved Metals: Standard Metals Package for General Chemistry;
- General Inorganic Parameters and Calculated Parameters: pH, Total Dissolved Solids, Electrical Conductivity, Hardness, Anion and Cation Sums.

Samples were collected by a technician wearing disposable Nitrile gloves, and samples were placed in laboratory-supplied sample bottles, labelled with a unique sample number, dated, and recorded on the laboratory chain of custody form. Samples were immediately placed in a cooler with ice for delivery to an accredited laboratory (Maxxam Analytics depot in London Ontario) under the chain of custody.

Copies of the Certificate of Analysis for each round of testing are provided in Appendix C, and results are summarized in Table 12.

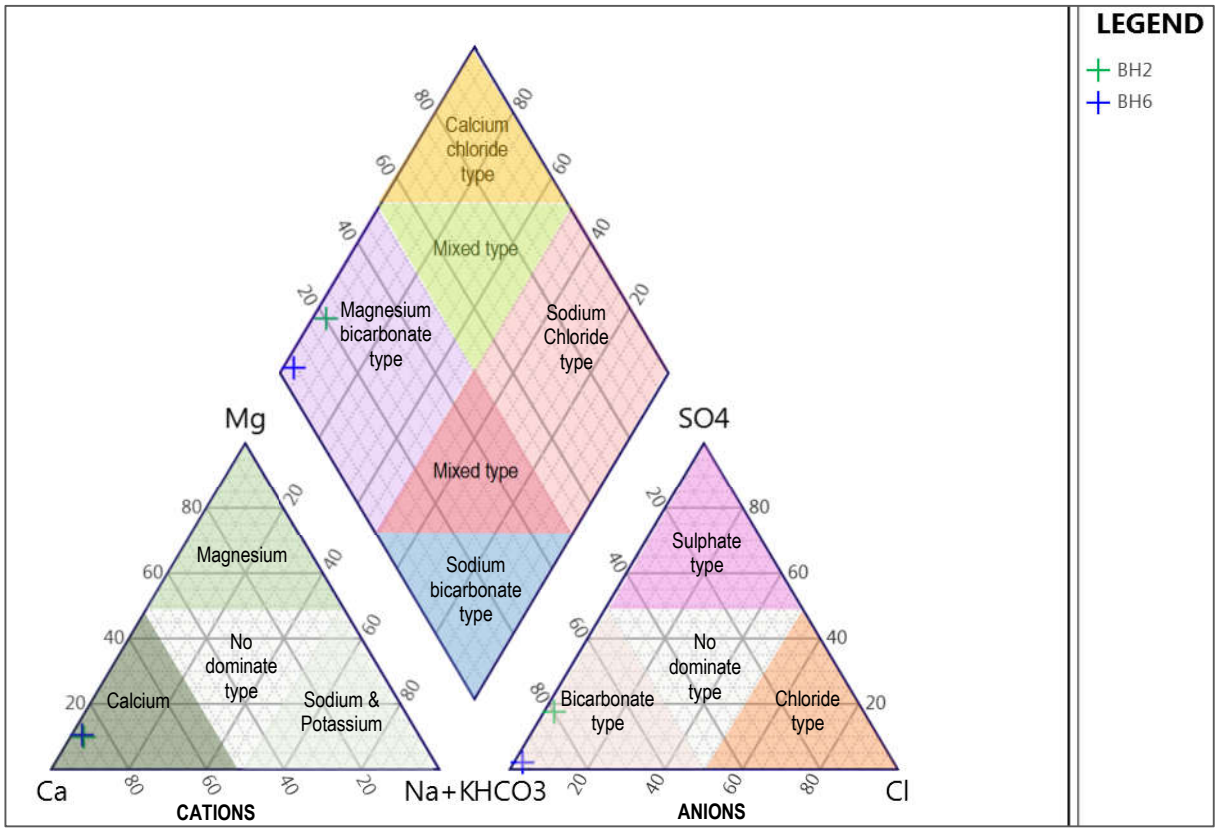
Table 12: Analytical Test Results

PARAMETER	UNITS	BH2 Groundwater Sample	BH6 Groundwater Sample
Metals			
Dissolved Aluminum (Al)	ug/L	<5.0	<5.0
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50
Dissolved Arsenic (As)	ug/L	<1.0	<1.0
Dissolved Barium (Ba)	ug/L	33	39
Dissolved Beryllium (Be)	ug/L	<0.50	<0.50
Dissolved Boron (B)	ug/L	12	<10
Dissolved Cadmium (Cd)	ug/L	<0.10	<0.10
Dissolved Calcium (Ca)	ug/L	96000	120000
Dissolved Chromium (Cr)	ug/L	<5.0	<5.0
Dissolved Cobalt (Co)	ug/L	0.63	<0.50
Dissolved Copper (Cu)	ug/L	<1.0	1.1
Dissolved Iron (Fe)	ug/L	<100	<100
Dissolved Lead (Pb)	ug/L	<0.50	<0.50
Dissolved Magnesium (Mg)	ug/L	18000	24000
Dissolved Manganese (Mn)	ug/L	600	48
Dissolved Molybdenum (Mo)	ug/L	1.9	0.80
Dissolved Nickel (Ni)	ug/L	1.2	<1.0
Dissolved Phosphorus (P)	ug/L	<100	<100
Dissolved Potassium (K)	ug/L	1000	890
Dissolved Selenium (Se)	ug/L	<2.0	<2.0
Dissolved Silicon (Si)	ug/L	5000	5400
Dissolved Silver (Ag)	ug/L	<0.10	<0.10
Dissolved Sodium (Na)	ug/L	5000	4900
Dissolved Strontium (Sr)	ug/L	140	130
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0
Dissolved Uranium (U)	ug/L	1.9	0.39
Dissolved Vanadium (V)	ug/L	0.65	<0.50
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0
Calculated Parameters			
Anion Sum	me/L	6.10	7.67
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	250	330
Calculated TDS	mg/L	330	410
Carb. Alkalinity (calc. as CaCO3)	mg/L	2.9	2.9
Cation Sum	me/L	6.48	8.16
Hardness (CaCO3)	mg/L	310	400
Ion Balance (% Difference)	%	3.00	3.09
Langelier Index (@ 20C)	N/A	1.05	1.12
Langelier Index (@ 4C)	N/A	0.804	0.873

PARAMETER	UNITS	BH2 Groundwater Sample	BH6 Groundwater Sample
Calculated Parameters - *continued*			
Saturation pH (@ 20C)	N/A	7.05	6.85
Saturation pH (@ 4C)	N/A	7.30	7.10
Inorganics			
Total Ammonia-N	mg/L	0.17	0.11
Conductivity	umho/cm	570	700
Dissolved Organic Carbon	mg/L	1.6	1.5
Orthophosphate (P)	mg/L	<0.010	<0.010
pH	pH	8.10	7.97
Dissolved Sulphate (SO4)	mg/L	35	4.6
Alkalinity (Total as CaCO3)	mg/L	250	330
Dissolved Chloride (Cl-)	mg/L	14	13
Nitrite (N)	mg/L	<0.010	<0.010
Nitrate (N)	mg/L	<0.10	7.79
Nitrate + Nitrite (N)	mg/L	<0.10	7.79

A review of the piper diagram provided on Figure 2, below, indicates that the shallow groundwater samples from each end of the site have a very similar water chemistry, with high levels of calcium and magnesium, which are consistent with hard water.

Figure 2: Piper Diagram



5.5 Groundwater Temperature Profiles

Temperature profiles were recorded in the monitoring wells in October 2019, November 2019 and January 2020.

A submersible pressure transducer with a data logger (Onset Hobo U20L unit) was used to record water temperatures at variable depths within each monitoring well. The temperature data points relative to depth in the water column for each location is shown graphically in Figure 3 (refer to page 26).

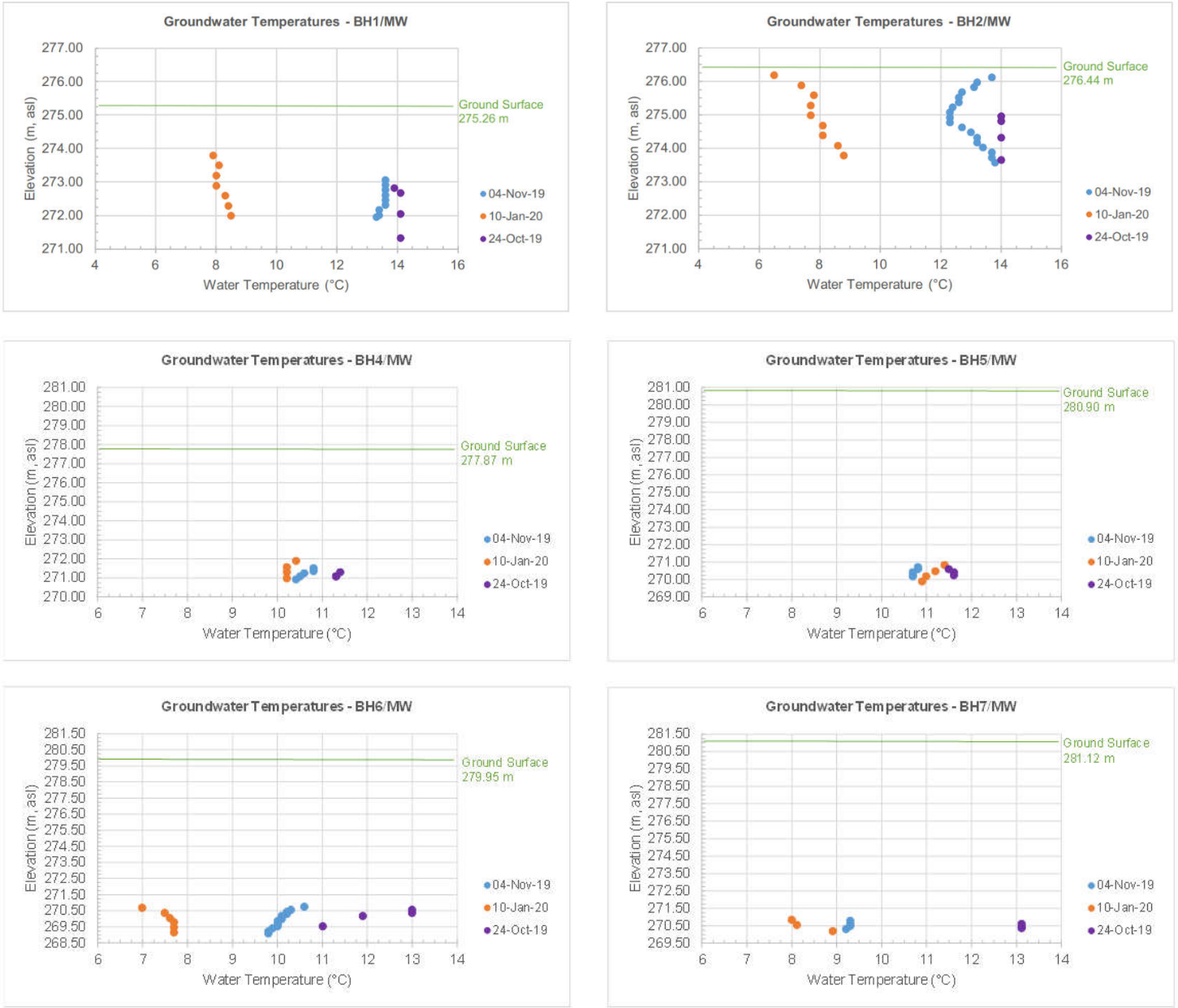
Shallow groundwater exhibits relatively wide temperature differences, while deeper groundwater has a much narrower range of temperature fluctuations. As the air and ground surface cools off, the colder air temperatures progressively move into the subsurface, resulting in water temperatures in the shallow groundwater being more significantly influenced by the ambient air and ground temperatures near surface since there is less ground cover to act as insulation for the groundwater. At greater depths, this effect is less pronounced.

As the depth to the saturated zone increases, the temperature spread becomes significantly narrower, which is demonstrated particularly well in boreholes BH5 and BH6.

Continuous groundwater temperatures were also recorded in Boreholes BH2, BH5 and BH6 for the period between August 15, 2019 and April 7, 2020 to document the baseline groundwater temperatures in the respective wells, and to note seasonal variations which occur within the shallow groundwater in the north end of the site and in the deeper wells set in the south and central part of the site. The results of the temperature monitoring are presented graphically on the hydrographs presented in Appendix D.

Figure 3

Groundwater Temperature Profiles



5.6 Groundwater and Surface Water Interaction

There is no open water body, watercourse or groundwater springs observed within the site limits.

Surface water drainage along Gore Road flows through a drainage ditch, along the south side of the road. Similarly, a drainage ditch follows the west side of Hunt Road. There is no proposed water diversion or storage, nor any proposed construction of drainage facilities on the Site.

Shallow groundwater encountered at the site is contained within a shallow groundwater aquifer, which is generally characterized as being unconfined, due to the limited thickness and variable permeability of the overburden silt which was documented in the boreholes. The shallow groundwater generally flows in a southerly direction throughout the site, towards the open gravel pit excavation/pond on the lands to the south.

It is important to note that the pond on the adjacent lands to the south was created as a result of the removal of overburden silts and excavation of aggregate/ sand and gravel material. As such, the water contained in the pond is expected to be directly connected to the shallow groundwater contacted in the boreholes in the south part of the study area. The large open body of water has the potential to contribute to increases in the temperature regime of the shallow groundwater, since the surface water temperature directly correlates with the ambient air temperature, however due to the depth of the shallow groundwater at the south end of the site, there is no discernable influence in the groundwater temperatures recorded in the wells closest to the south end of the site.

6. IMPACTS OF PROPOSED OPERATIONS

6.1 Proposed Aggregate Extraction

A test pit program completed at the site by Thames Valley Aggregates, and the findings of this report confirm the presence of granular materials which have commercial value to the owner. The natural sand and gravel soils encountered at the site extend below the shallow groundwater table. As such, extraction of the granular material will require excavation below the stabilized groundwater table, if extraction of materials above the natural strata of silt till is planned. It is anticipated that these materials will be extracted with hydraulic excavator. Consideration may also be given to extraction methods below the groundwater table may also utilize a dragline set-up.

It is understood that aggregate extraction operations at the site will involve the excavation of sand, and sand and gravel soils from above and below the water table. Aggregate deposits are relatively fine grained and thin in the north part of the site, limited by a layer of silt till which was contacted within the boreholes. However, in the central and south end of the site, the thickness of the granular deposits increases significantly, extending below the borehole exploration depth of 11.1 m in the south end of the site. The deepest extraction activity is expected at the south end of the site, with the overall extraction depths in the south end of the site are expected to be similar to those at the Nicli Pit, located immediately south of the site.

Where possible, sand and gravel soils are expected to be completely removed until the clayey silt till is reached. The elevation of the clayey silt till, which underlies the aggregate deposits, is delineated on the cross sections provided on Drawing 6. During the active extraction operation, it is anticipated that portions of the site will be occupied by ponds where extraction extends below the water table. As noted in the Rehabilitation Plan prepared by Harrington McAvan Ltd., the finished pond area is expected to be about 11.33 hectares in size, at completion.

Given the local presence of nearby water supply wells, and wetland areas to the north, a Level 2 evaluation as described by the Ministry of Natural Resources and Forestry standards for aggregate licence applications, is warranted.

6.2 Impacts to the Shallow Groundwater Level

The aggregate extraction will be carried out using an excavator and/or dragline, without the need for dewatering, and when extraction is complete, an 11.97 hectare pond is expected to remain at the site. As noted above, the depth of excavation is expected to vary across the site, to effectively extract and utilize the aggregate.

The proposed aggregate extraction activities which extend below the water table have the potential to cause temporary lowering of the water table in the vicinity of the proposed operation during active excavation. Two primary causes have been identified, as follows:

- The removal of sand and gravel may initially and temporarily result in short-duration localized effects on the groundwater level being lowered near the perimeter of the pond area.

- The potential change in water budget due to the increase in evaporation from an open water body and increased surface runoff into the pond.

Both aspects were examined, and subsequent calculations were made to see if these aspects have any realistic chances of having any negative impacts. The following subsections address the analyses which was carried out for the site.

6.2.1 Groundwater Lowering from Active Excavation

Removal of aggregate material may cause a small lowering of the water level in the pond as the extraction progresses, as a result of a localized zone of depression where active excavation occurs. When a given volume of aquifer material (saturated sand and gravel) is removed, most of the water in the excavator bucket or dragline drains back into the pond. In addition, the excavated material is typically stockpiled near the pond are, so excess moisture in the gravel can drain back towards the pond. A volume of water roughly equal to the volume of excavated sand and gravel flows from the existing pond, and groundwater, into the void created by extracting the sand and gravel. The overall water level drops slightly as the void space is filled. The effect of this marginal drawdown can instantly be observed at the pond edge, but will be localized to the area of excavation.

Using an estimated porosity of the granular material of 0.30, the volume of aquifer solids removed in 1 m^3 bucket is 0.70 m^3. When an excavated pond is small, the change in volume caused by the removal of granular material has the greatest effect on the water level in the pond. As pond size increases, there is more water available in relation to the extraction of one bucket of material, so the effects of extraction become lessened.

Using an estimated daily tonnage of 3000 tonnes, a typical aggregate density of 1780 kg/m^3, a porosity of 0.30, the following calculation can be carried out:

$$Volume\ of\ water\ to\ fill\ excavation = (1 - soil\ porosity)\ x\ \frac{aggregate\ tonnage}{aggregate\ density}$$

The volume of excavated water that will need to flow into the excavated area to replace the sand and gravel is approximately 1180 m^3.

The following calculations (refer to Table 13) are provided for approximate pond sizing for Area 1, 2 and 3 as outlined on the Harrington McAvan Operations Drawings, which have been estimated as a 4 ha pond, an 8 ha pond and the ultimate pond configuration of 11.33 ha. Although the pond base is expected to be stepped up towards the northerly extent of the extraction area, an average pond depth of 5 m has been used in the calculations, to demonstrate the maximum daily drawdown caused by aggregate excavation.

Water level in the pond during the early phase of extraction for the smaller pond size may show daily lowering of less than 3 cm but is expected to be temporary and recover within 24 hours. During later phase of extraction when the pond approaches its maximum size, this lowering is expected to be much less, as noted above. This value is insignificant and would not cause any groundwater drawdown for any significant distance outside of the immediate pond area.

Table 13: Drawdown Calculations during Active Extraction

Inputs	4.0 ha pond	8.0 ha pond	11.33 ha pond
Estimated Volume of Water in Pond = AxB, Where: A = area of Pond B = depth of Pond	A = 40,000 m^2 B = 5 m Pond Volume =200,000 m^3	A = 80,000 m^2 B = 5 m Pond Volume = 400,000 m^3	A = 113,300 m^2 B = 5 m Pond Volume = 566,500 m^3
Maximum daily drawdown caused by extraction = ho – [(V1-V2)/A] Where: ho = Initial Pond level V1 = Pond volume (calculated above) V2 = Volume of excavation void A = area of Pond (shown above)	*Maximum daily drawdown caused by extraction* *= ho – [(V1-V2)/A]* = 5.0 – [(200,000-1180)/40,000] = 0.029 m	*Maximum daily drawdown caused by extraction* *= ho – [(V1-V2)/A]* = 5.0 – [(400,000-1180)/80,000] = 0.015 m	*Maximum daily drawdown caused by extraction* *= ho – [(V1-V2)/A]* = 5.0 – [(566,500-1180)/113,300] = 0.010 m

The domestic wells nearest to the Site are located north and east of the site. Although some of them obtain water from the water table aquifer, lowering water levels in the pond due to the proposed operation is inconsequential to water quantity in these domestic wells. The zone of influence associated with the minor changes to the water level do not extend far enough to reach the neighbouring properties.

6.2.2 Water Budget and Increased Evaporation

LDS has carried out a monthly water balance analysis for the site, under both existing and proposed rehabilitated conditions. As noted previously, the predominant soils encountered at the site are comprised of sand or sand and gravel soils, which in turn overlie silt till. Shallow groundwater is contained within the unconfined aquifer within the sand and gravel soils. The following table summarizes the recommended elements of the assessment, and provides a reference to the corresponding material within this report.

Table 14: Components of Water Balance Analysis

Conservation Ontario Recommended Element of the Water Balance Assessment	Reference
Obtain precipitation values from a reliable source such as Environment Canada Meteorological Services	Environment Canada Climate Normals 1981 – 2010, London International Airport - Station ID 6144475, London, Ontario Precipitation = 984 mm/year
Estimate of local values for major water balance components (evapotranspiration, surplus, runoff, and infiltration) for pre-development, post-development and post-development with mitigation conditions	Estimated pre and post-development values of evapotranspiration, surplus, runoff, and infiltration are summarized in the following paragraphs. Calculation Work Sheets prepared by LDS are provided in Appendix G. The relationship between precipitation, evapotranspiration, run-off and infiltration is prorated using the local precipitation amount (determined, as noted above), and based on the relationship shown on Table 3.1 of the MOECC Stormwater Management Planning and Design Manual.
The water balance is required to take into account the changes to grading / topography and land cover	Variables such as elevation, surficial soils, hydrologic soil group, vegetation, root zone, grading and topography are taken into account when estimating the existing and proposed post development water balance components.
Appropriate catchments should be used within the analysis (i.e. delineate catchments based on drainage, grades, vegetation, soils and show how infiltration and runoff will change within these zones for both pre and post development)	The site limits have been identified as the pre-development and post-development catchment area.
All calculations should be provided in a table format which clearly demonstrates that inputs (precipitation, additional runoff, water from municipal well, etc.) are equal to outputs (i.e. infiltration runoff, water use)	Calculations are presented in table format on the attached water balance calculation sheets provided in Appendix G.

Precipitation, evapotranspiration, total runoff, and infiltration was reviewed utilizing a method authored by C. W. Thornthwaite and J. R. Mather in their 1957 paper titled Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance. The methodology can be found in the MECP SWM Planning and Design Manual, Section 3.2.

The basic water balance for a region can be expressed as:

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

Where, P = Precipitation (rain and snow)
RO = Runoff
ET = Evapotranspiration
I = Infiltration (Groundwater Recharge)
ΔS = Change in Groundwater Storage (assumed to be zero under steady state conditions).

Precipitation is a measured value, with the averages (1981 to 2010) used in this assessment being obtained from the Environment Canada operated London International Airport Climate Station. Evapotranspiration is calculated based on measured air temperatures. Infiltration and runoff are calculated based on precipitation and evapotranspiration, where the difference between these components is the water surplus available for infiltration and recharge.

Water balance calculation worksheets (including a description of the methodology and assumptions) are provided in Appendix G. The following summarizes the existing water balance volumes under existing (pre-development) and post-development (rehabilitation) conditions.

Annual water budget for the Site in its current state indicates that: of the 984 mm of annual precipitation, 548 mm is lost to evapotranspiration, 240 mm infiltrates into the ground, and 219 mm leaves the Site as runoff. After rehabilitation, a portion of the post-development run-off will be split between evaporation and infiltration, and as a result, the water balance calculations result in evaporation increasing to 645 mm, infiltration increasing to 273 mm, and 66 mm of run-off remaining. Under the rehabilitated site conditions, there is an increase in water lost to evaporation (evapotranspiration under existing conditions) and an increase to infiltration; however, runoff leaving the site would be reduced. This results in a small net gain to the groundwater system, which is interconnected to the surface water within the future pond.

6.3 Permanent Changes to Shallow Groundwater

As noted previously, the wetland area within the northern wooded area is primarily supported from surface flows which are conveyed through a culvert at Hunt Road, and disperse through the wetland area. Under seasonal (spring-high) conditions, a portion of the wetland may also be supported by shallow groundwater conditions. Within the wetland area, seasonal fluctuations and dry periods in the summer months have been identified by the project ecologist. A physical outlet in the form of a culvert beneath Gore Road is present for surface flows leaving the site, and provides an outlet control to prevent flooding within the wetland area.

The presence of the pond, as identified in the final site configuration shown on the Site Rehabilitation Plan will result in a decreased gradient in the shallow groundwater throughout the site. Under current conditions, the shallow groundwater table drops approximately 5 m from north to south, and a higher flow gradient is present in the east end of the site. The final pond elevation is expected to be at Elevation +/- 273 m, asl, which falls within the central range of the stabilized water levels recorded at the site. Similar to the groundwater characteristics which are currently present at the site, it is anticipated that a higher flow gradient will remain at the northerly limit of the site, in proximity to the northern wooded area where shallow perched groundwater will continue to remain within the unconfined aquifer set above the less permeable silt till soils.

Alterations to the site within the extraction area and the creation of the pond are not expected to significantly alter the base flows which sustain the northern woodland and the wetland area contained there-in, since surface water flow contributions will be unaltered by the development, and the predominant shallow groundwater flow direction from north to south (which provides a base flow contribution under seasonal conditions) will also be unaffected by the proposed aggregate operations.

6.4 Impacts to Groundwater Temperatures

The Groundwater Contour Plans provided on Drawings 7 and 8 show a shallow groundwater flow direction to the south, away from both the Thames River (to the east),Caddy Creek and its tributary drains (to the west), and the wetland area (to the north). Given that in both late summer and spring conditions, the groundwater flow direction remains predominantly to the south, and away from the natural surface water features and surface water-dependent features, it is anticipated that the introduction of a pond at the site as a result of below water gravel extraction will not result in thermal impacts being imposed on the natural surface water features.

Further, an existing pond exists at the Nicli Pit, on the lands to the south. Water temperatures within the onsite pond is expected to be similar to that of the existing pond. The cumulative effect of groundwater warming as a result of the warm groundwater conditions that are anticipated in the pond during warm summer months, relative to the groundwater temperature have the potential to impact down-gradient groundwater and surface water features. However, infiltration into the subgrade soils, and the time required for the infiltration along with the lateral and vertical migration of infiltrated water will provide time for water temperatures to adjust to levels similar to those within the shallow groundwater. As such, the effects of localized warming of surface water at the site is not expected to cause a detrimental effect to nearby upgradient or downgradient natural features.

7. CONTINGENCY PLAN AND MITIGATION MEASURES

7.1 Construction Equipment

The proposed aggregate extraction operation is expected to involve excavation of sand, and sand and gravel materials from above and below the water table. In such a situation, the use of equipment for site operations may pose a potential risk of petroleum hydrocarbons such as fuels, oil and grease to enter the exposed groundwater system unless the proper operation and refuelling procedures are followed.

There are best management and good construction practices that should be followed to reduce the potential and mitigate risks associated with the equipment operation. The following recommendations are provided for consideration:

- Onsite fuel storage tanks will be installed and maintained in accordance with the Gasoline Handling Act;
- Designated fuelling and equipment maintenance area, located at least 30 m away from surface water features, where possible;
- Crushers, stackers and screening plants shall be re-fuelled and maintained on the pit floor during daylight hours. Any minor drips or spills shall be immediately cleaned up and properly disposed of; and,
- Implement spill contingency measures and spill action response plans for construction equipment.

7.2 Sediment and Erosion Control Measures

It is anticipated that surficial topsoil and overburden soils will be stripped as part of the site preparation works, and stored onsite for reuse during the site restoration. It is recommended that stockpiled materials which have been stripped during the site preparation be stored in areas where stormwater run-off will not drain directly into roadside drainage ditches, or into the woodlot being maintained at the north end of the site.

Earthen berms constructed at the site should be vegetated as soon as possible after placement, to help stabilize the berm side slopes.

7.3 Potable Water Supply Interference

The following water well interference complaint protocol is recommended to address water supply interference to domestic and farm water supplies for properties located in proximity (within 150 m) to the site.

1. Nearby and neighbouring properties shall be provided with 24-hour emergency contact information for the Licensee, to facilitate reporting of perceived water supply impacts.
2. Nearby and neighbouring properties which experience disruption or quality problems shall notify the Licensee, who will be responsible to report the well interference complain to MNRF and MECP.
3. In the event that the well owner experiences a significant disruption in their water supply, or experience significant adverse effects upon their water quality; and if the operation of the pit cannot obviously and definitively be excluded as the cause, the licensee shall provide a temporary water supply within 24

hours and thereafter until such time as the cause of the disturbance can be determined and the situation addressed.

4. The Licensee shall investigate the cause of the water supply disturbance and shall report to the MNRF, MECP and the well owner.
5. If it is determined that the aggregate extraction at the pit has been found to have caused a domestic or farm water supply to be adversely affected, the Licensee shall, at the Licensees expense, either restore or replace the water supply to ensure that historic water supply and quality are restored for such a resident. If it is determined that the operation of the pit has not caused any domestic or farm water supply to be adversely affected, the temporary water supply will be maintained for an additional 24 hours to allow the resident to make alternate water supply arrangements.

8. MONITORING PROGRAM

There is no proposed dewatering of the gravel pit. Aggregate extraction is proposed for excavation below the water table using an excavator or a drag line. Changes to water balance are small and inconsequential, and localized changes which are expected to result in a flattening of the groundwater gradient are not expected to have an adverse impact on the northern woodlot and wetland areas which are being maintained.

In the event that there is a perceived impact identified through environmental monitoring at the site, or in the event that interference of disturbance is identified for nearby water supply wells is reported by nearby or neighbouring properties, interim water quality testing should be carried out within 24 hours of the reported incident, to document conditions which may have been impacted. Scoping for the required testing will depend on the incident report.

Groundwater quality has been assessed for existing / baseline conditions, as presented in Section 5.4. If future groundwater quality testing is required, it can be compared against the existing baseline information provided in this report.

The existing monitoring wells which are located around the perimeter of the site may be suitable for continued use for monitoring water levels. A site plan showing all wells to be maintained and protected at the site should be provided to the Licensee working, to ensure that monitoring wells are not inadvertently damaged during site preparation works and removal of overburden materials. Vertical extensions or risers for the monitoring wells may be required to accommodate changes in site grades or the construction of earthen berms around the perimeter of the site. The use of a datalogger would provide continuous monitoring of both water levels and water temperatures at the site.

Manual water level measurements should be carried out on a quarterly basis once the site is licensed and continue until extraction is completed and the site has been rehabilitated. Timing of the quarterly reporting should coincide with annual regulatory compliance reporting requirements which are required to be submitted on September 30 of each year, to ensure that data submitted to the Ministry of Natural Resources is as current as possible.

When the monitoring wells are determined to be no longer required, the wells should be properly decommissioned in accordance with Ontario Regulation 903. This regulation identifies that only certified and qualified well drilling technicians are permitted to direct the decommissioning work for existing wells. Decommissioning a well which is no longer in use helps to ensure the safety of those in the vicinity of the well, prevents surface water infiltration into an aquifer via the well, prevents the vertical movement of water within a well, conserves aquifer yield and hydraulic head and can potentially remove a physical hazard.

9. CONCLUSIONS AND RECOMMENDATIONS

Based on the information collected in the field and analysis of available data, the following conclusions are made:

1. There is a substantial thickness of sand, and sand and gravel soils at the site, which has been deemed to be a financially viable aggregate extraction resource. Aggregate extraction is expected to include both above and below water operations.
2. Above and below water aggregate extraction is already occurring on adjacent licensed aggregate pits, and have resulted in surface water features, particularly on the lands immediately south of the site.
3. The shallow unconfined groundwater aquifer is the most likely aquifer to have a risk of adverse impacts associated with the proposed site activities.
4. Only a limited number of water supply wells are present in proximity to the site, and well records generally indicate that wells are set into intermediate depth overburden deposits.
    - Aggregate extraction operations are not expected to involve active dewatering efforts, therefore significant impacts to nearby water supply wells are expected to be negligible.
    - Provided that the contractor follows best management practices for equipment maintenance and fuelling activities, the risk of water quality impact is expected to be negligible.
5. Groundwater flow direction has been identified to be in a southerly direction. The wetland area located on the north side of Gore Road is upgradient of the site, and as such, is not expected to be adversely impacted by operations at the site.
6. The hydrogeological site assessment and associated calculations indicate that the proposed aggregate extraction from below the water table will not have any adverse effect on local water resources, including domestic water wells, nor on any of the natural environment features in the area.

Based on the conclusions drawn from the work described herein, the following recommendations are made and should be incorporated into the site plans:

1. Fuel storage, equipment filling, and equipment maintenance should be carried out in accordance with best management practices outlined in Section 6.1, including designated fuelling locations and implementation of spills management response plans, as appropriate to reduce the potential and mitigate risks associated with the equipment operation.
2. Water levels have been carried out on a monthly basis since the inception of the monitoring wells which were installed onsite. Groundwater level monitoring should continue at the site on a quarterly basis after the pit is licensed, and continue until site restoration is complete.
3. Groundwater samples have been collected at the site to establish baseline water quality conditions for shallow groundwater within the unconfined aquifer which is expected to be encountered during the aggregate extraction operation. Future water quality testing can be compared to the background information presented in this report, if required.
4. If complains are received from nearby or neighbouring property owners (within 120 m of the site), the Water Supply Interference Protocols outlined in Section 6.2 of this report should be adhered to.

10. ASSESSOR QUALIFICATIONS

This report was prepared by Ms. P.E. 'Tara' Sieg, BA Env. MA, Geo-Environmental Scientist. Ms. Sieg has over 15 years of experience in conducing Environmental, Geotechnical and Ecological studies under the supervision of Professional Engineers and/or Geoscience QPs, and is routinely engaged in Environmental and Hydrogeological field work.

This assessment was supervised and reviewed by Mrs. Rebecca Walker, P. Eng., QPESA, who has been thoroughly trained in conducting geotechnical and hydrogeological assessments. Mrs. Walker is a licensed professional engineer in the Province of Ontario. She obtained a Bachelor of Applied Science in Geological Engineering from Queen's University in 1998 and is a Qualified Person (QPESA) registered with MECP, under the requirements of Ontario Regulation 153.

Rebecca provides geotechnical and geoscience services under the *Guideline of Professional Engineers Providing Geotechnical Engineering Services* under the Professional Engineers Act in Ontario. Rebecca is qualified to provide geoscience (hydrogeological) services under the Professional Geoscientists Act as an exempted engineer, by virtue of her training and experience, as prescribed by the Professional Engineers Act.

Mrs. Walker has over 20 years of direct experience in the geotechnical and hydrogeological consulting industry. Over 3,800 projects have been completed under her supervision. Mrs. Walker is also a recognized expert in the industry and has testified as an expert witness in Ontario Municipal Board and Local Planning Appeals Tribunal hearings, and Municipal Councils related to groundwater hydrogeology and geotechnical matters for land development, aggregate extraction and various types of construction projects. She has been retained for many projects, both directly and indirectly by local municipalities as a hydrogeological and geotechnical consultant.

11. REFERENCES

Chapman, L.J. and Putnam, D.F., 1984. The Physiography of Southern Ontario Third Edition. Ontario Geological Survey Special Volume 2. Ministry of Natural Resources.

Dillon Consulting Limited, 2004, Middlesex-Elgin Groundwater Study, Final Report, Project No. 02-0394

Environment Canada, 2015. Canadian Climate Normals, Volume 9, Soil Temperature, Lake Evaporation, Days with Blowing Snow, Hail, Fog, Smoke or Haze, Frost, 1981 -2010.

Ontario Division of Mines, Quaternary Geology, Lucan Area, Southern Ontario, Preliminary Map P1048, scale 1:50,000, 1975

Ontario Geological Survey, Bedrock Topography of the Lucan Area, Southern Ontario, Preliminary Map P291, scale 1:50,000, 1980 compilation.

Ontario Ministry of the Environment, 1981. Thames River Basin, Water Management Study, Technical Report, Groundwater Resources. Water Resources Report 14.

Ontario Ministry of Natural Resources, 1997. Aggregate Resources of Ontario, Provincial Standards, Version 1.0. Queens Printer for Ontario.

Singer, S.N., Cheng, C.K., Scafe, M,G, 2003 The Hydrogeology of Southern Ontario, 2nd Edition, Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment.

Thames-Sydenham and Region Source Protection Committee, 2015. Thames-Sydenham and Region Source Protection Committee, Upper Thames River Source Protection Area, Assessment Report, Approved September 17, 2015.

12. CLOSING

The information presented in this report is based on a scoped investigation designed to provide information to support an assessment of the hydrogeological setting at the subject property, for the project described in the text of the report.

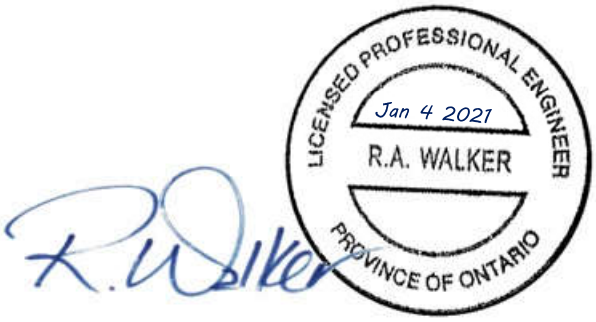
It is important to note that this assessment involves a limited sampling of the subsurface conditions at specific borehole locations. The conclusions and recommendations presented in this report reflect site conditions existing at the time of the investigation and a review of available information which has been presented in the report. Should subsurface conditions be encountered which vary materially from those observed in the boreholes, we recommend that LDS be consulted to review the additional information and verify if there are any changes to the recommendations and discussion provided in this report.

No portion of this report may be used as a separate entity. It is intended to be read in its entirety. LDS should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented.

We trust this satisfies your present requirements. If you have any questions or require anything further, please feel free to contact our office.

Respectfully Submitted,

LDS CONSULTANTS INC.



P.E. Tara Sieg, BA Env. MA
Geo-Environmental Scientist
Office: 226-289-2952
Cell: 519-933-2686
tara.sieg@LDSconsultants.ca

Rebecca A. Walker, P. Eng., QP$_{ESA}$
Principal, Geotechnical Services
Office: 226-289-2952
Cell: 519-200-3742
rebecca.walker@LDSconsultants.ca

APPENDIX A

DRAWINGS

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

Site Features & Surrounding Land Use

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	**1**

2006 AERIAL PHOTOGRAPH

SOURCE:
Google Earth Pro, Version 7.3.2.5776,
Coordinates 17T, 499062 m E, 4763562 m N,
Imagery date 05/06/2006

2018 AERIAL PHOTOGRAPH

SOURCE:
Google Earth Pro, Version 7.3.2.5776,
Coordinates 17T, 499062 m E, 4763562 m N,
Imagery date 07/02/2018

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

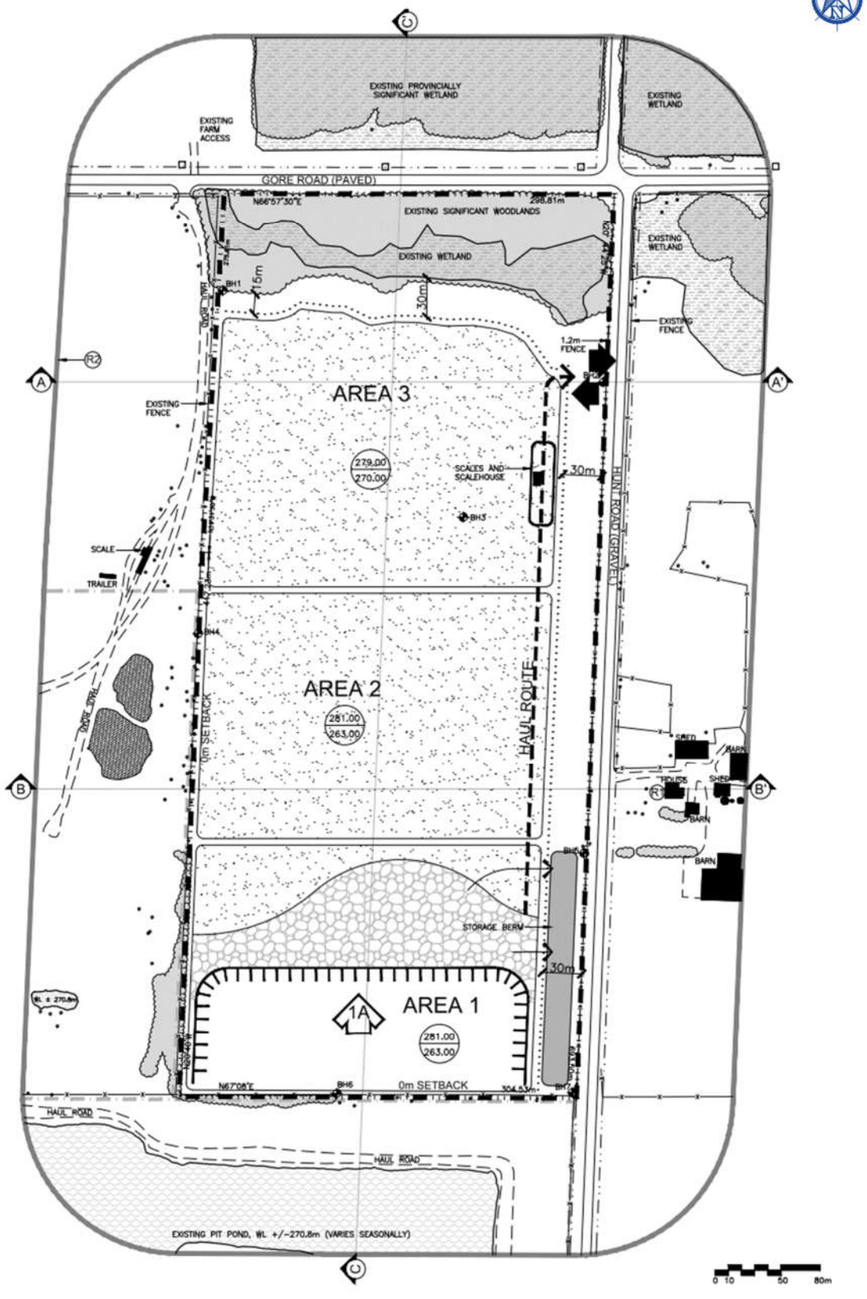
Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

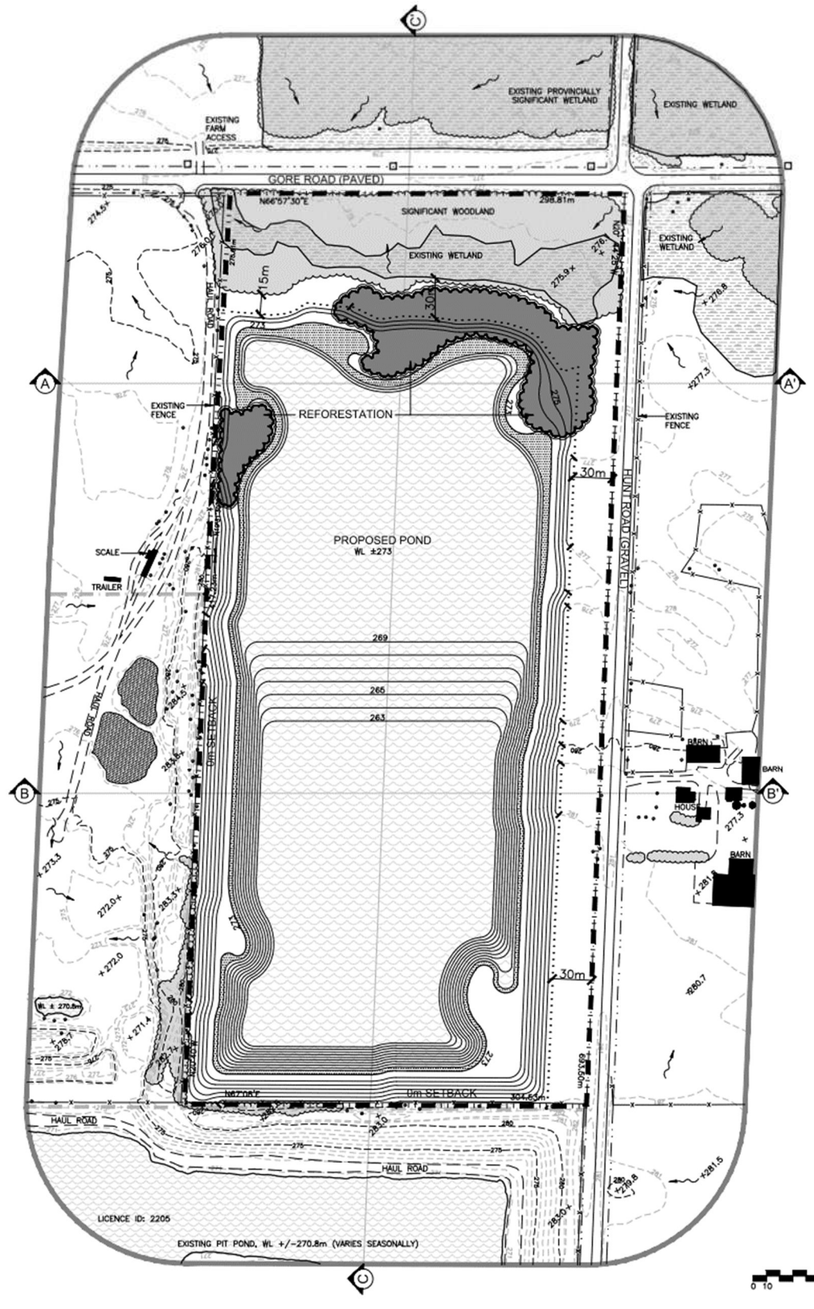
Aerial Photographs

SCALE	PROJECT NO.
As Shown	GE-00260
DATE	**DRAWING NO.**
January 2021	**2**

Operations Plan – Phase A



Rehabilitation Plan



SOURCE:
Project Drawings, prepared by Harrington McAvan Ltd., Project Number 20-23, December 2020

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

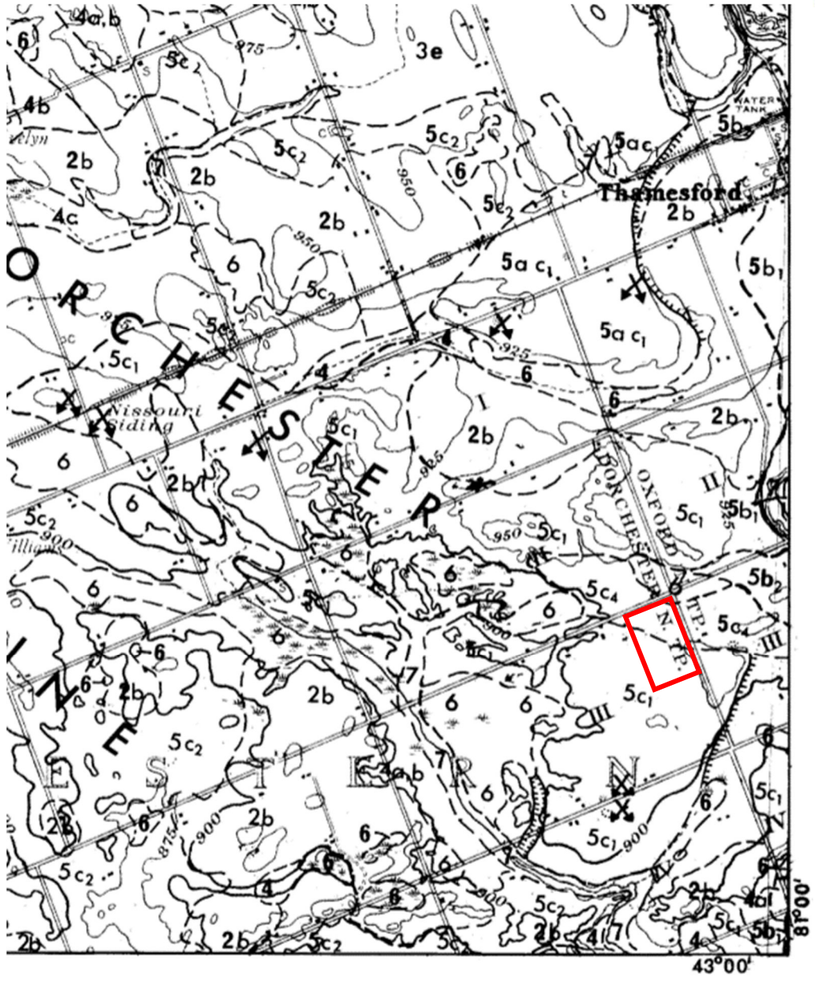
Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

Operations and Rehabilitation Plan
(Excerpts)

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	3

QUATERNARY GEOLOGY



PLEISTOCENE
LATE WISCONSINAN

5 Gravels and Related Sediments[a]: Gravel, gravelly sand, sand

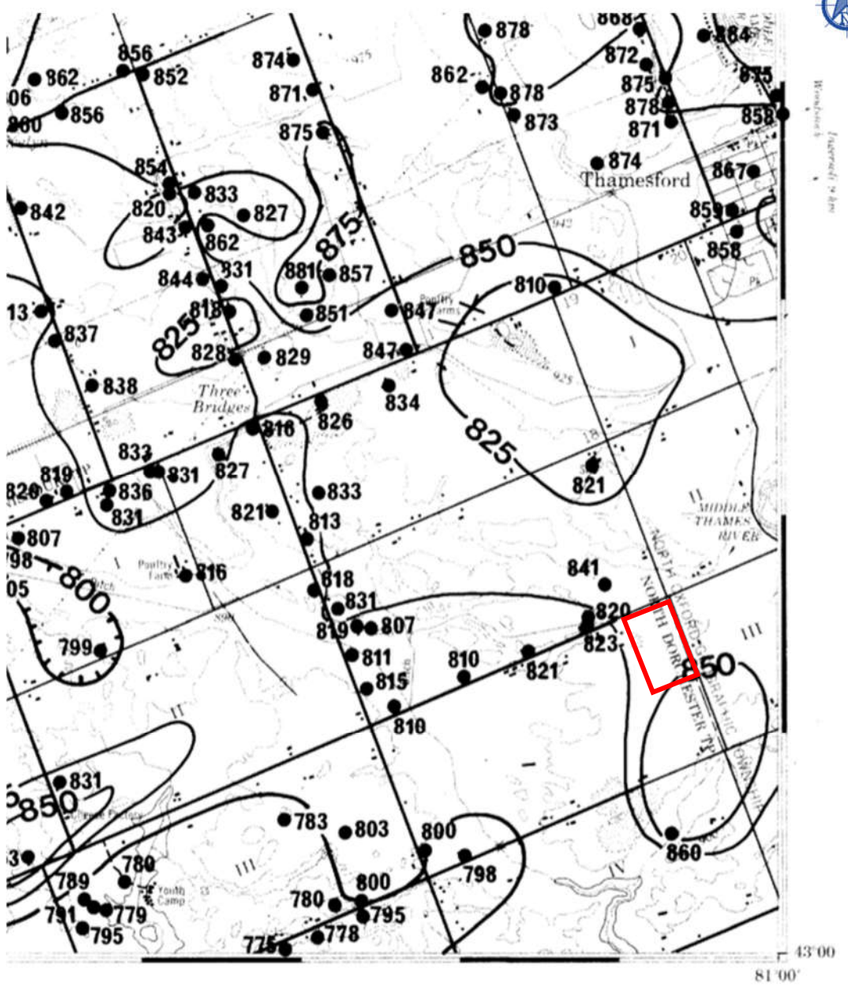
(a) Deltaic and some beach complex deposits
1. gravel
2. gravelly sand

(b) Outwash
1. predominantly gravel (some sand)
2. predominantly sand (some gravel)

(c) Ice-contact Stratified Drift
1. predominantly gravel (some sand, silt and till)
2. predominantly sand (some gravel, silt and till)
3. predominantly till (some gravel, sand and silt)
4. predominantly silt (some gravel, sand and till)

SOURCE:
Quaternary Geology, Lucan Area, Southern Ontario, Ontario Division of Mines, Preliminary Map P1048, scale 1:50,000, 1975

BEDROCK TOPOGRAPHY



● 926 Elevation of bedrock surface as obtained from water well record (feet above sea level)*

757 Elevation of bedrock surface as obtained from oil or gas well record (feet above sea level)*

■ 932 Elevation of bedrock surface as obtained from geo-technical reports (consultants) and from boreholes for stratigraphic control (Sado). (feet above sea level)*

125 Contour line of bedrock elevation (interval, 25 feet)

SOURCE:
Bedrock Topography of the Lucan Area, Southern Ontario, Ontario Geological Survey, Preliminary Map P291, scale 1:50,000, 1980 compilation.

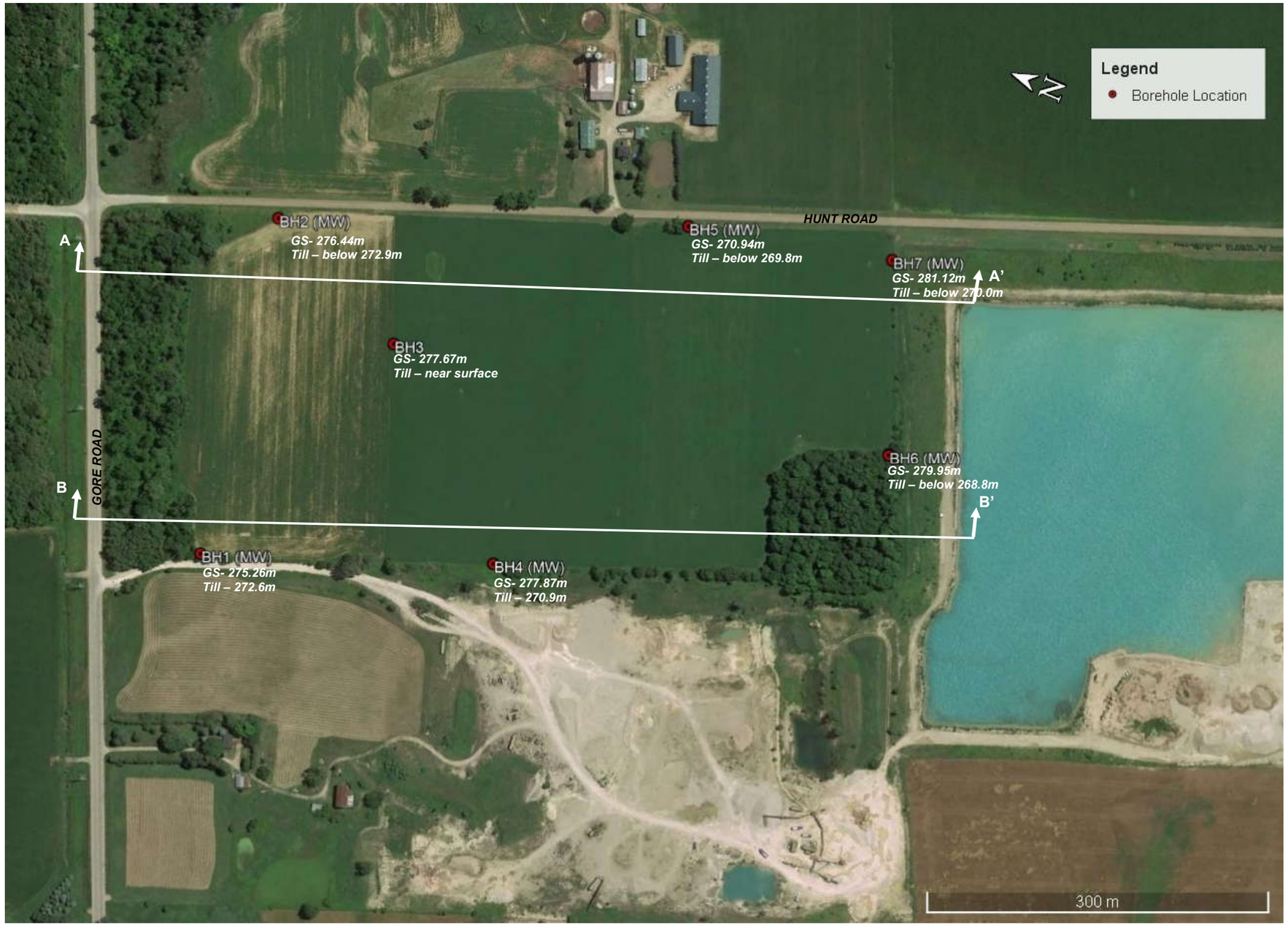
LDS

PROJECT NAME
Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION
Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME
Geologic Mapping

SCALE	PROJECT NO.
As Shown	GE-00260
DATE	**DRAWING NO.**
January 2021	**4**



LEGEND

GS-276.44 m	Ground Surface Elevation (m, asl)
Till – 272.9 m	Elevation of Silt Till Strata (m, asl)

NOTE:
Refer to Drawing 4 for Cross Section Drawings

SOURCE:
Google Earth Pro, Version 7.3.2.5776,
Coordinates 17T, 499062 m E, 4763562 m N,
Imagery date 7/2/2018

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

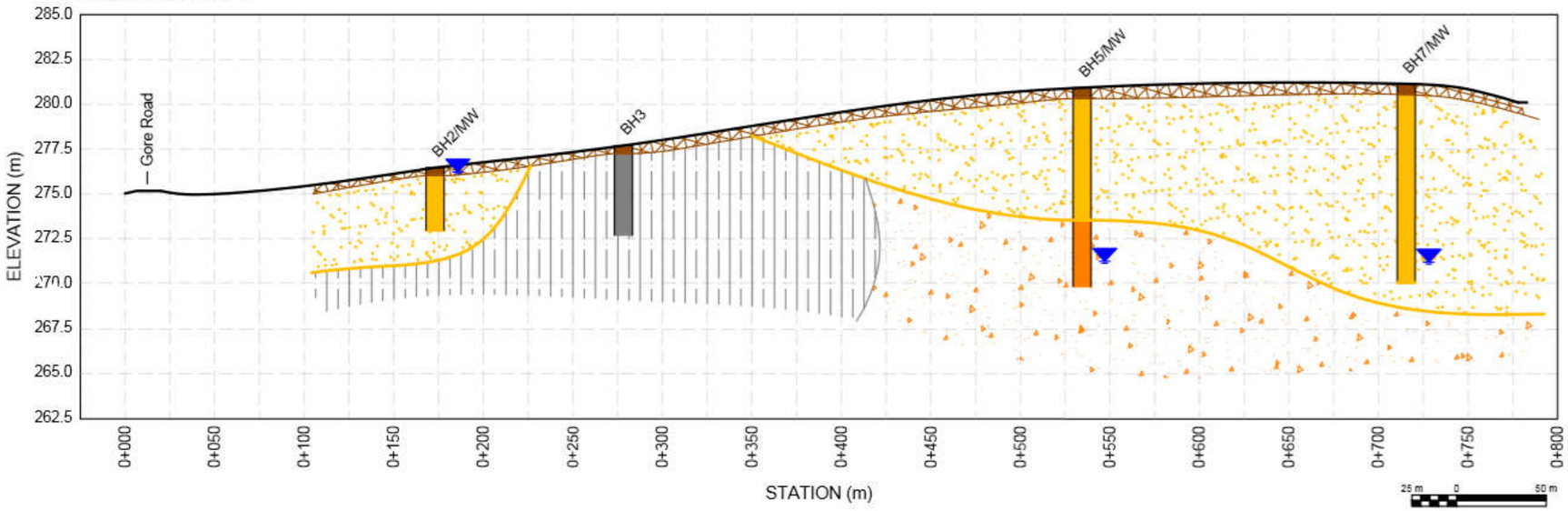
Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

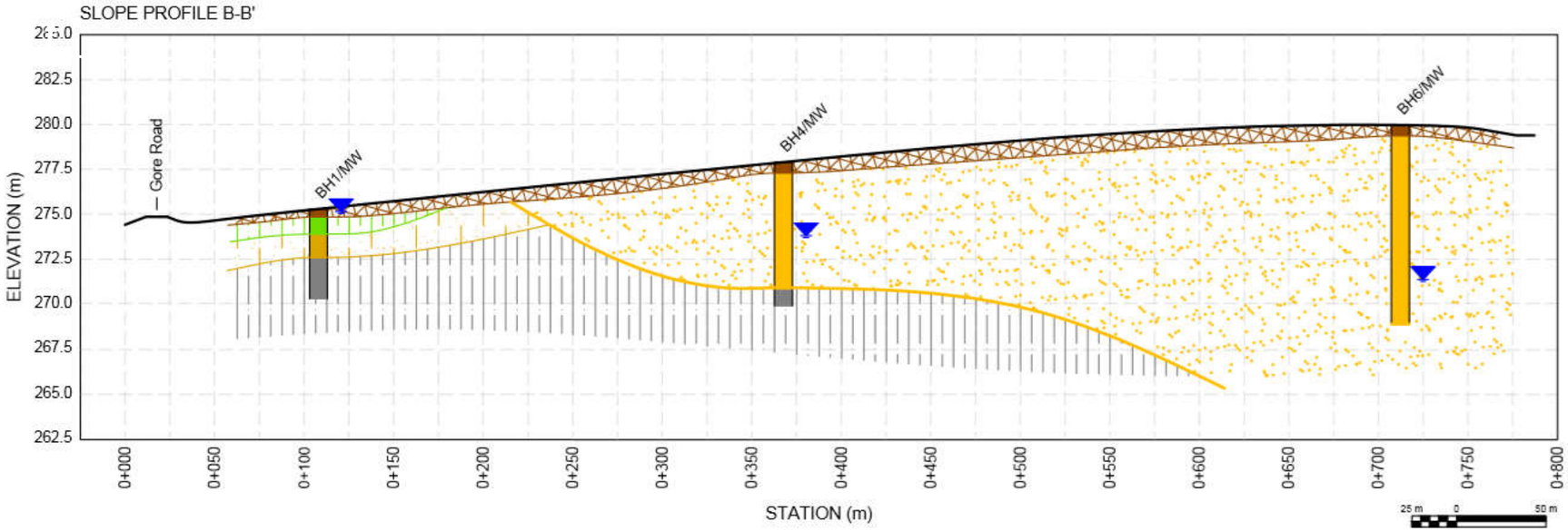
Borehole Location Plan

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	**5**

SLOPE PROFILE A-A'



SLOPE PROFILE B-B'



LEGEND:

- TOPSOIL
- SAND
- SILTY SAND
- SAND AND GRAVEL
- SILT
- SILT TILL
- GROUNDWATER LEVEL (March 2020)

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

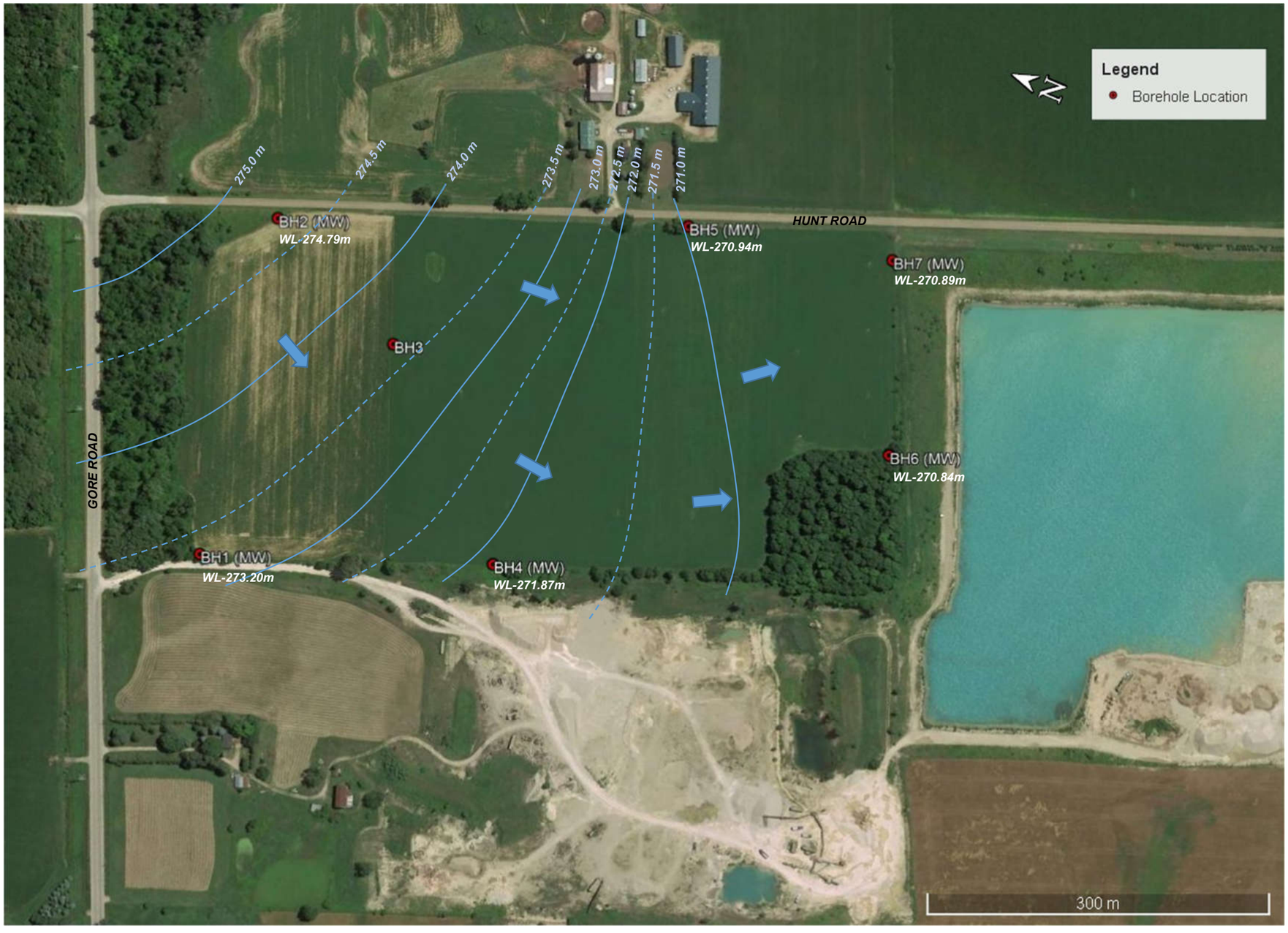
PROJECT LOCATION

Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

Cross Sections

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	**6**



LEGEND

	Groundwater Contour
WL-237.22m	Groundwater Elevation, m
	Groundwater Flow Direction (inferred)

NOTES

1. Groundwater measurements taken on September 29, 2019.
2. Groundwater contours and groundwater flow direction have been inferred from groundwater measurements, as shown.

SOURCE:
Google Earth Pro, Version 7.3.2.5776,
Coordinates 17T, 499062 m E, 4763562 m N,
Imagery date 7/2/2018

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

Groundwater Contour Plan
(Fall 2019)

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	***DRAWING NO.***
January 2021	**7**

LEGEND

	Groundwater Contour
WL-275.11m	Groundwater Elevation, m
	Groundwater Flow Direction (inferred)

NOTES

1. Groundwater measurements taken on March 5, 2020
2. Groundwater contours and groundwater flow direction have been inferred from groundwater measurements, as shown.

SOURCE:
Google Earth Pro, Version 7.3.2.5776,
Coordinates 17T, 499062 m E, 4763562 m N,
Imagery date 7/2/2018

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

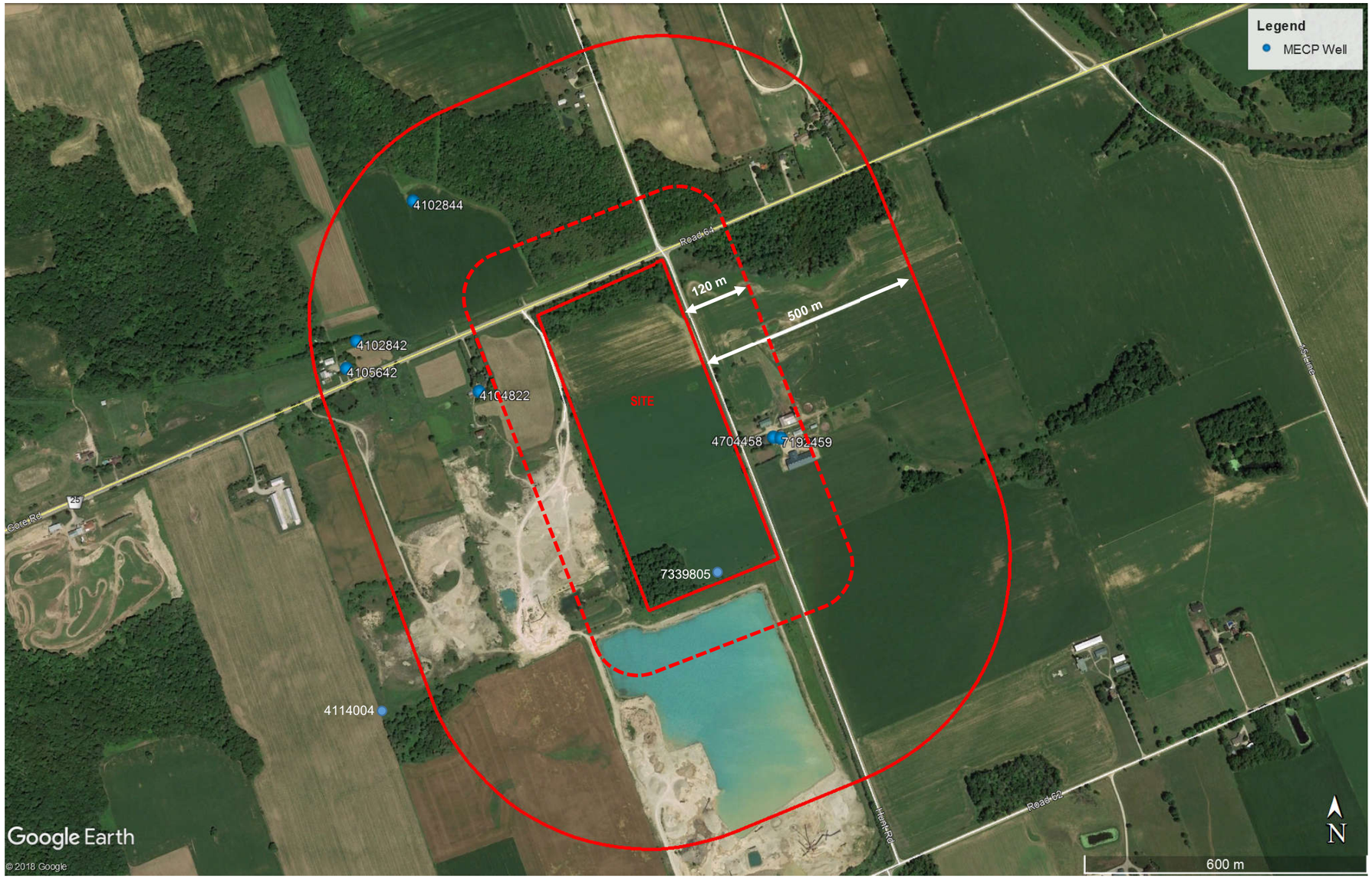
PROJECT LOCATION

Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

Groundwater Contour Plan
(Spring 2020)

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	***DRAWING NO.***
January 2021	**8**



SOURCE:

MECP Well Records: www.ontario.ca/environment-and-energy/map-well-records, updated January 24, 2020

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

MECP Well Locations

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	9

Ontario **Source Protection Information Atlas**
Ministry of the Environment, Conservation and Parks

Result Details

Searched By:
Map location
Value:
User identified location

Water Quality | Policy Search by SPA | Water Quantity

Location Information

Zoom in to confirm your location and results.

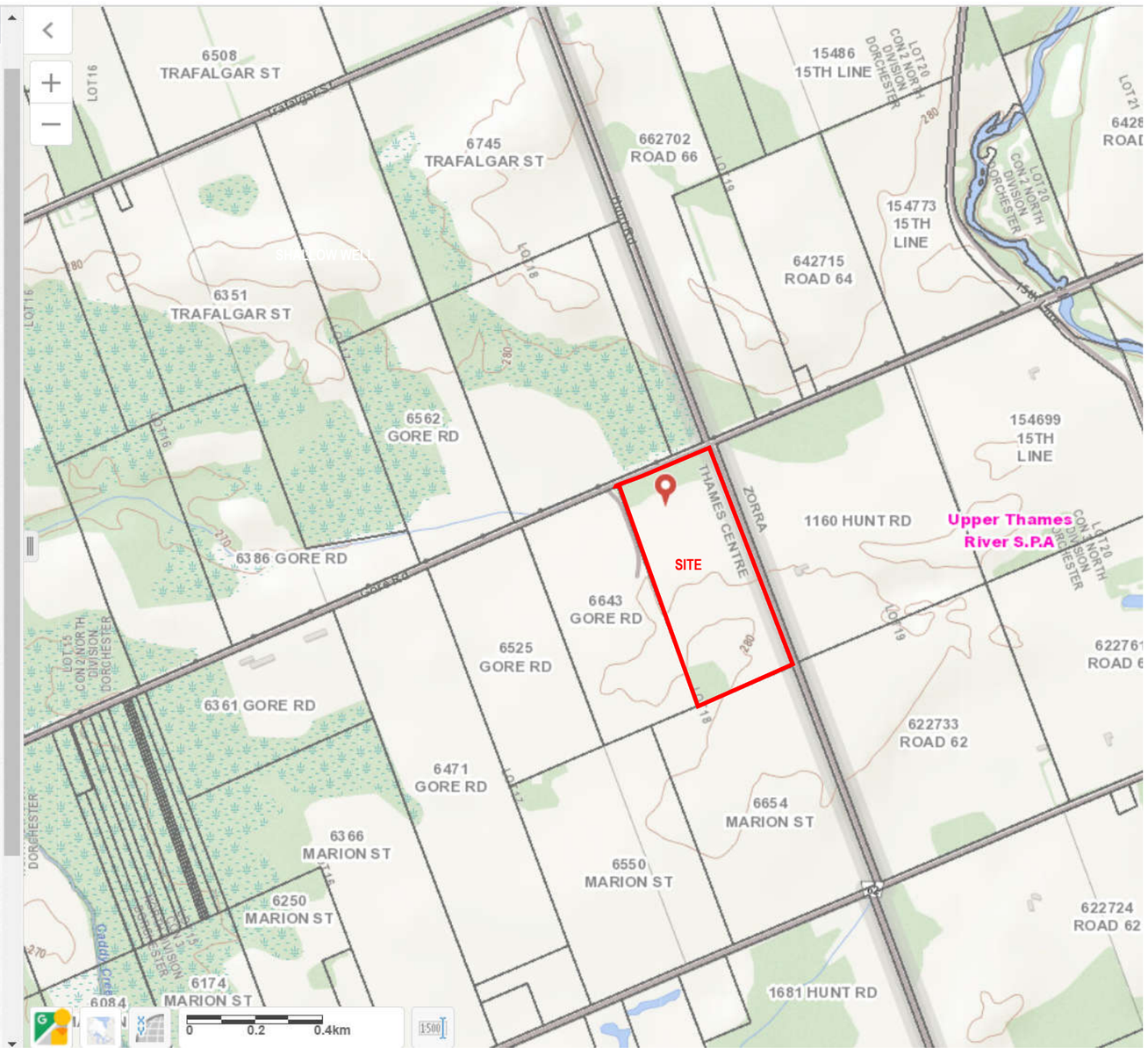
Latitude: **43.02558** Longitude: **-81.013**
UTM Zone: **17** Easting: **498940.71** Northing: **4763655.65**
Upper Tier Municipality: **COUNTY OF MIDDLESEX**
Lower/Single Tier Municipality: **MUNICIPALITY OF THAMES CENTRE**
Township Concession and Lot: **DORCHESTER CON 3 NORTH DIVISION, LOT 18**
Assessment Parcel Address: **N/A**
Assessment Roll #: **39260000201250000000**
MECP District: **London**
MECP Region: **Southwestern**

Source Protection Details for Location

Source Protection Area. **Upper Thames River**
Wellhead Protection Area: **No**
Wellhead Protection Area E (GUDI): **No**
Intake Protection Zone: **No**
Issue Contributing Area: **No**
Significant Groundwater Recharge Area: **No**
Highly Vulnerable Aquifer: **No**
Event Based Area: **No**
Wellhead Protection Area Q1: **No**
Wellhead Protection Area Q2: **No**
Intake Protection Zone Q: **No**

Use the Policy search tab to see if any policies apply – for more details see the source protection plan

Information is current as of: **January 10, 2020**



SOURCE:
MECP Source Protection Information Atlas Mapping, www.gisapplication.lrc.gov.on.ca/SourceWaterProtection, current to January 10, 2020

LDS

PROJECT NAME
Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION
Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME
Source Protection Information Atlas

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	10

Looking Northwest from the southeast corner of the property, at Hunt Road.

Looking Northwest along the east side of the property, towards the wooded area.

Looking west across the central part of the property.

Looking West into the wooded area at the north end of the site.

SOURCE:
Photographs taken by LDS field inspector.
September 27, 2019

LDS

PROJECT NAME

Proposed Aggregate Pit (Pike Farm)

PROJECT LOCATION

Part Lot 18, Concession 3 NRT,
Geographic Township of North Dorchester

DRAWING NAME

Site Photographs
September 2019

SCALE	PROJECT NO.
As Shown	GE-00251
DATE	**DRAWING NO.**
January 2021	11

APPENDIX B

BOREHOLE SUMMARY &
GRAIN SIZE ANALYSES

NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the Canadian Foundation Engineering Manual soil classification system, based on visual and tactile examination which are consistent with the field identification procedures. Soil descriptions and classifications are based on the Unified Soil Classification System (USCS), based on visual and tactile observations. Where grain size analyses have been specified, mechanical grain size distribution has been used to confirm the soil classification.

Soil Classification (based on particle diameter)
Clay: < 0.002 mm
Silt: 0.002 – 0.075 mm
Sand: 0.075 – 4.75 mm
Gravel: 4.75 mm – 75 mm
Cobbles: 75 – 200 mm
Boulders: > 200 mm

Terminology & Proportion
Trace: < 10%
Some: 10-20%
Adjective, sandy, gravelly, etc.: 20-35%
And, and gravel, and silt, etc.: > 35%
Noun, Sand, Gravel, Silt, etc.: > 35% and main fraction

2. The compactness condition of cohesionless soils is based on excavator / drilling resistance, and Standard Penetration Test (SPT) N-values where available. The Canadian Foundation Engineering Manual provides the following summary for reference.

Compactness of Cohesionless Soils	SPT N-Value (# blows per 0.3 m penetration of split-spoon sampler)
Very Loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	50+

3. Topsoil Thickness - It should be noted that topsoil quantities should not be established from information provided at the test hole locations only. If required, a more detailed analysis with additional test holes may be recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

4. Fill material is heterogeneous in nature, and may vary significantly in composition, density and overall condition. Where uncontrolled fill is contacted, it is possible that large obstructions or pockets of otherwise unsuitable or unstable soils may be present beyond the test hole locations.

5. Where glacial till is referenced, this is indicative of material which originates from a geological process associated with glaciation. Because of this geological process, till must be considered heterogeneous in composition and as such, may contain pockets and / or seams of material such as sand, gravel, silt or clay. Till often contains cobbles or boulders and therefore, contractors may encounter them during excavation, even if they are not indicated on the test hole logs. Where soil samples have been collected using borehole sampling equipment, it should be understood that normal sampling equipment can not differentiate the size or type of obstruction. Because of horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with excavations in till material.

6. Consistency of cohesive soils is based on tactile examination and undrained shear strength where available. The Canadian Foundation Engineering Manual provides the following summary for field identification methods and classification by corresponding undrained shear strength.

Consistency of Cohesive Soils	Field Identification	Undrained Shear Strength (kPa)
Very Soft	Easily penetrated several cm by the fist	0 – 12
Soft	Easily penetrated several cm by the thumb	12 – 25
Firm	Can be penetrated several cm by the thumb with moderate effort	25 – 50
Stiff	Readily indented by the thumb, but penetrated only with great effort	50 – 100
Very Stiff	Readily indented by the thumb nail	100 – 200
Hard	Indented with difficulty by the thumbnail	200+

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **1/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 1*
	Project Number	**GE-00260**	

Date Drilled	**July 19, 2019**	Ground Surface Elevation (m asl)	**275.26**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**1.8 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**N. Ungerer**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					0.45 m	**TOPSOIL** - brown, sandy loam, 450 mm	
0.5						**SILT** - brown, trace sand, compact, moist	
1.0	X	1	AS		1.40 m		
1.5						**SILTY SAND / SANDY SILT** - brown, fine grained, compact, wet	
2.0	X	2	AS				*MC - 25.9%*
2.5	X	3	AS		2.70 m	*Gradation Results* *55.6% Silt, 44.4% Sand*	*MC - 20.6%*
3.0						**SILT TILL** - grey, trace sand and fine gravel, dense, moist	
3.5		4	70	49		- 60 mm wet sand and gravel seam encountered at	
4.0							
4.5							
5.0		5	70	30	5.00 m		*MC - 17%*
5.5						*Borehole terminated at 5.0 m depth.* *Well Installed upon completion.*	
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**3.1 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 1.2 m**

Additional Notes

MC - denotes moisture content

WATER LEVEL MEASUREMENTS

Date	Depth (m)	Elev (m asl)
22-Jul-19	1.53	273.73
08-Aug-19	1.91	273.35

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **2/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 1*
	Project Number	**GE-00260**	

Date Drilled	**July 22, 2019**	Ground Surface Elevation (m asl)	**276.44**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**1.3 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**N. Houlton, EIT**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					0.45 m	**TOPSOIL** - brown, sandy loam, 450 mm	
0.5						**SAND** - brown, fine grained, trace to some silt, loose to compact, very moist	
1.0	☒	1	AS				*MC - 19.7%*
1.5	☒	2	AS				*MC - 18.3%*
2.0							
2.5	☒	3	AS			- saturated below 2.3 m depth.	*MC - 17.8%*
3.0	◢	4	100	20	*3.50 m*	*Gradation Results* *10.9% Silt, 88.7% Sand*	*MC - 19.6%*
3.5						*Borehole terminated at 3.5 m depth.* *Well Installed upon completion.*	
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**3.1 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 1.2 m**

Additional Notes

MC - denotes moisture content

WATER LEVEL MEASUREMENTS

Date	Depth (m)	Elev (m asl)
22-Jul-19	0.59	275.85
08-Aug-19	1.37	275.07

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **3**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 1*
	Project Number	**GE-00260**	

Date Drilled	**July 22, 2019**	Ground Surface Elevation (m asl)	**277.67**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**No seepage observed**
Drilling Method	**Hollow Stem Auger**	Technician	**N. Houlton, EIT**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					0.45 m	**TOPSOIL** - brown, sandy loam, 450 mm	
0.5						**SILT TILL** - brown, trace sand and fine gravel, compact, moist	
1.0	⊠	1	AS				
1.5							
	⊠	2	AS				*MC - 10.2%*
2.0							
2.5	⊠	3	AS				*MC - 10.5%*
3.0						- grey below 3.0 m depth	
	◪	4	80	27			
3.5							
4.0							
4.5							
	◪	5	AS		5.00 m		*MC - 16.3%*
5.0						*Borehole terminated at 5.0 m depth.* *Open and dry upon completion.*	
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

- ◪ SPT Sample
- ⊠ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **4/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 1*
	Project Number	**GE-00260**	

Date Drilled	**July 18, 2019**	Ground Surface Elevation (m asl)	**277.87**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**5.6 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**N. Houlton, EIT**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.0						**TOPSOIL** - brown, sandy loam, 600 mm	
					0.60 m		
1.0	X	1	AS			**SAND** - brown, fine grained, trace to some gravel, trace	
1.5						- becoming compact below 1.4 m depth	
2.0	X	2	AS				*MC - 11.9%*
2.5	X	3	AS				*MC - 3.9%*
3.0							
3.5	◢	4	90	17		- medium to coarse grained sand with some gravel below 2.6 m depth	*MC - 3.8%*
4.0							
4.5							
5.0	X	5	AS		▼		
5.5						- becoming saturated below 5.5 m depth	
6.0							
6.5	◢	6	80	19		*Gradation Results* *3.4% Silt, 77.1% Sand, 19.5% Gravel*	*MC - 11.9%*
7.0					7.00 m		
7.5	X	7	AS			**SILT TILL** - grey, trace sand and fine gravel, dense, moist	
8.0					8.00 m		
						Borehole terminated at 8.0 m depth. *Well Installed upon completion.*	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**6.6 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 5.0 m**

Additional Notes

MC - denotes moisture content

WATER LEVEL MEASUREMENTS

Date	Depth (m)	Elev (m asl)
22-Jul-19	5.26	272.61
08-Aug-19	5.61	272.26

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **5/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 2*
	Project Number	**GE-00260**	

Date Drilled	**July 10, 2019**	Ground Surface Elevation (m asl)	**280.90**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**9.8 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**R. Walker**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.5						**TOPSOIL** - brown, sandy loam, 600 mm	
					0.60 m		
1.0	X	1	AS			**SAND** - brown, fine grained, trace to some gravel,	*MC - 8.6%*
1.5	X	2	AS				
2.0							
2.5	X	3	AS			- compact with some gravel below 2.6 m depth	*MC - 3.2%*
3.0	◢	4	40	32			*MC - 3.2%*
3.5							
4.0							
4.5	X	5	AS				
5.0							
5.5							
6.0	◢	6	70	26			*MC - 2.8%*
6.5							
7.0							
					7.40 m		
7.5	X	7	AS			**SILTY SAND AND GRAVEL** - brown, well-graded, dense, moist	
8.0						*continued on the following page*	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**10.7 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 8.9 m**

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **5/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 2 of 2*
	Project Number	**GE-00260**	

Date Drilled	**July 10, 2019**	Ground Surface Elevation (m asl)	**280.90**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**9.8 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**R. Walker**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
8.5							
9.0							
	SPT	8	80	50			*MC - 10.4%*
9.5						- becoming saturated below 9.5 m depth	
10.0							
10.5							
	SPT	9	70	49	*11.1 m*	*Gradation Results* *21.3% Silt, 51.9% Sand, 26.8% Gravel*	*MC - 9.7%*
11.0							
11.5						*Borehole terminated at 11.1 m depth.* *Well Installed upon completion*	
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**10.7 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 8.9 m**

Additional Notes

WATER LEVEL MEASUREMENTS

Date	Depth (m)	Elev (m asl)
22-Jul-19	9.75	271.149
08-Aug-19	9.82	271.079

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **6/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 2*
	Project Number	**GE-00260**	

Date Drilled	**July 10, 2019**	Ground Surface Elevation (m asl)	**279.95**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**9.0 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**R. Walker**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.5						**TOPSOIL** - brown, sandy loam, 600 mm	
					0.60 m		
1.0	Bulk	1	AS			**SILTY SAND** - brown, fine grained, trace to some gravel, loose, moist	
1.5	Bulk	2	AS				*MC - 7.6%*
2.0							
2.5	Bulk	3	AS			- trace to some cobbles (up to 50 mm) present near 2.5 m	
3.0	SPT	4	70	43			*MC - 2.8%*
3.5							
4.0							
4.5	Bulk	5	AS			- becoming medium grained, trace silt below 4.5 m depth.	*MC - 3.4%*
5.0							
5.5							
6.0	SPT	6	80	16			*MC - 3.5%*
6.5							
7.0							
7.5	Bulk	7	AS				
8.0							
						continued on the following page	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**10.7 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 8.9 m**

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **6/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 2 of 2*
	Project Number	**GE-00260**	

Date Drilled	**July 10, 2019**	Ground Surface Elevation (m asl)	**279.95**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**9.0 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**R. Walker**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
8.5						- saturated below 9.5 m depth	
9.0					▼		
	SPT	8	70	22		*Gradation Results* *8.3% Silt, 91.6% Sand, 0.1% Gravel*	*MC - 16.6%*
9.5							
10.0							
10.5							
11.0	SPT	9	70	24	***11.1 m***		*MC - 20%*
11.5						*Borehole terminated at 11.1 m depth.* *Well Installed upon completion*	
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**10.7 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 8.9 m**

Additional Notes

WATER LEVEL MEASUREMENTS

Date	Depth (m)	Elev (m asl)
22-Jul-19	8.88	271.066
08-Aug-19	9.00	270.946

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **7/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 1 of 2*
	Project Number	**GE-00260**	

Date Drilled	**July 10, 2019**	Ground Surface Elevation (m asl)	**281.12**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**9.0 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**R. Walker**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.0						**TOPSOIL** - brown, sandy loam, 600 mm	
0.5					*0.60 m*		
1.0	⊠	1	AS			**SILTY SAND** - brown, fine grained, trace to some gravel, compact, moist	
1.5	⊠	2	AS				*MC - 2.4%*
2.0							
2.5	⊠	3	AS			- trace to some cobbles (up to 50 mm) present near 2.5 m	
3.0	◪	4	70	22		- medium grained below 3.0 m depth.	*MC - 3.2%*
3.5							
4.0							
4.5	⊠	5	AS				
5.0							
5.5							
6.0	◪	6	80	20		- fine sand with trace silt below 6.0 m depth.	*MC - 3.3%*
6.5							
7.0							
7.5	⊠	7	AS				*MC - 3.2%*
8.0							
						continued on the following page	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**10.7 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 8.9 m**

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Aggregate Pit (Pike Farm)**	Borehole ID **7/MW**
	Project Location	**Pt Lot 18, Conc 3 NRT, Twp. of North Dorchester**	*Sheet 2 of 2*
	Project Number	**GE-00260**	

Date Drilled	**July 10, 2019**	Ground Surface Elevation (m asl)	**281.12**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion (m)	**9.0 m, bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**R. Walker**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**N. Houlton, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
8.5						- becoming saturated below 9.5 m depth	
9.0					▼		
	SPT	8	70	22			
9.5							
10.0							
10.5							
11.0	SPT	9	70	24	11.1 m	*Gradation Results* *16.2% Silt, 83.8% Sand*	*MC - 16.3%*
11.5						*Borehole terminated at 11.1 m depth.* *Well Installed upon completion*	
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**10.7 m**
Screen Length	**1.5 m**
Depth of Bentonite Seal	**0 - 8.9 m**

Additional Notes

WATER LEVEL MEASUREMENTS

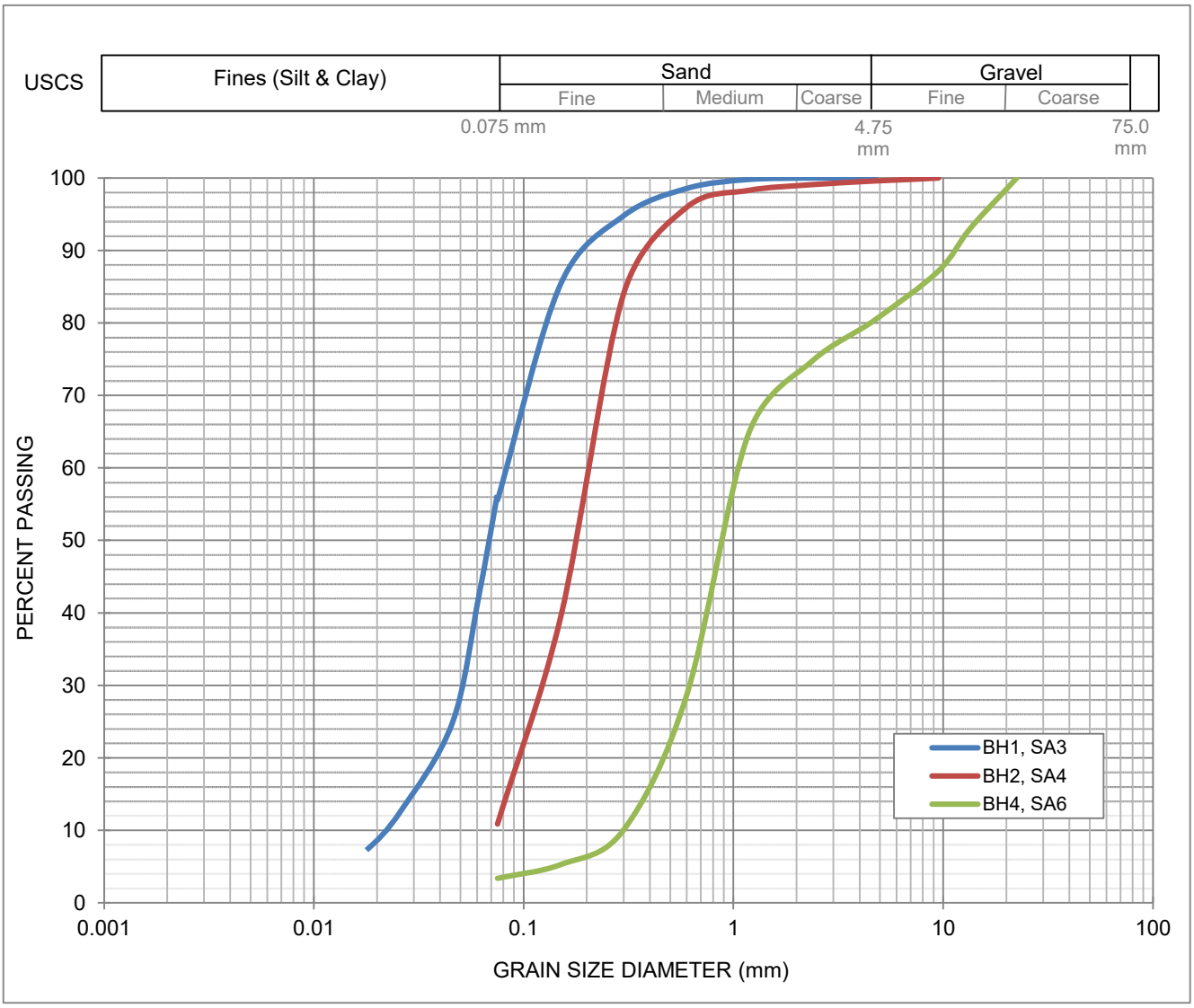
Date	Depth (m)	Elev (m asl)
22-Jul-19	9.92	271.204
08-Aug-19	10.09	271.034

Particle Size Distribution
Results of Sieve Analysis

Project Name: Aggregate Pit Site **Date:** 19-Sep-19

Project Location: Part Lot 18, Concession 3 NRT
Geographic Township of North Dorchester **Project No.:** GE-00260

Sample ID	Unified Soil Classification				Moisture Content (%)
	Fines (Silt & Clay)	% Sand	% Gravel	% Cobbles	
BH1, SA3	55.6%	44.4%	0.0%	0.0%	20.6
BH2, SA4	10.9%	88.7%	0.4%	0.0%	19.6
BH4, SA6	3.4%	77.1%	19.5%	0.0%	11.9

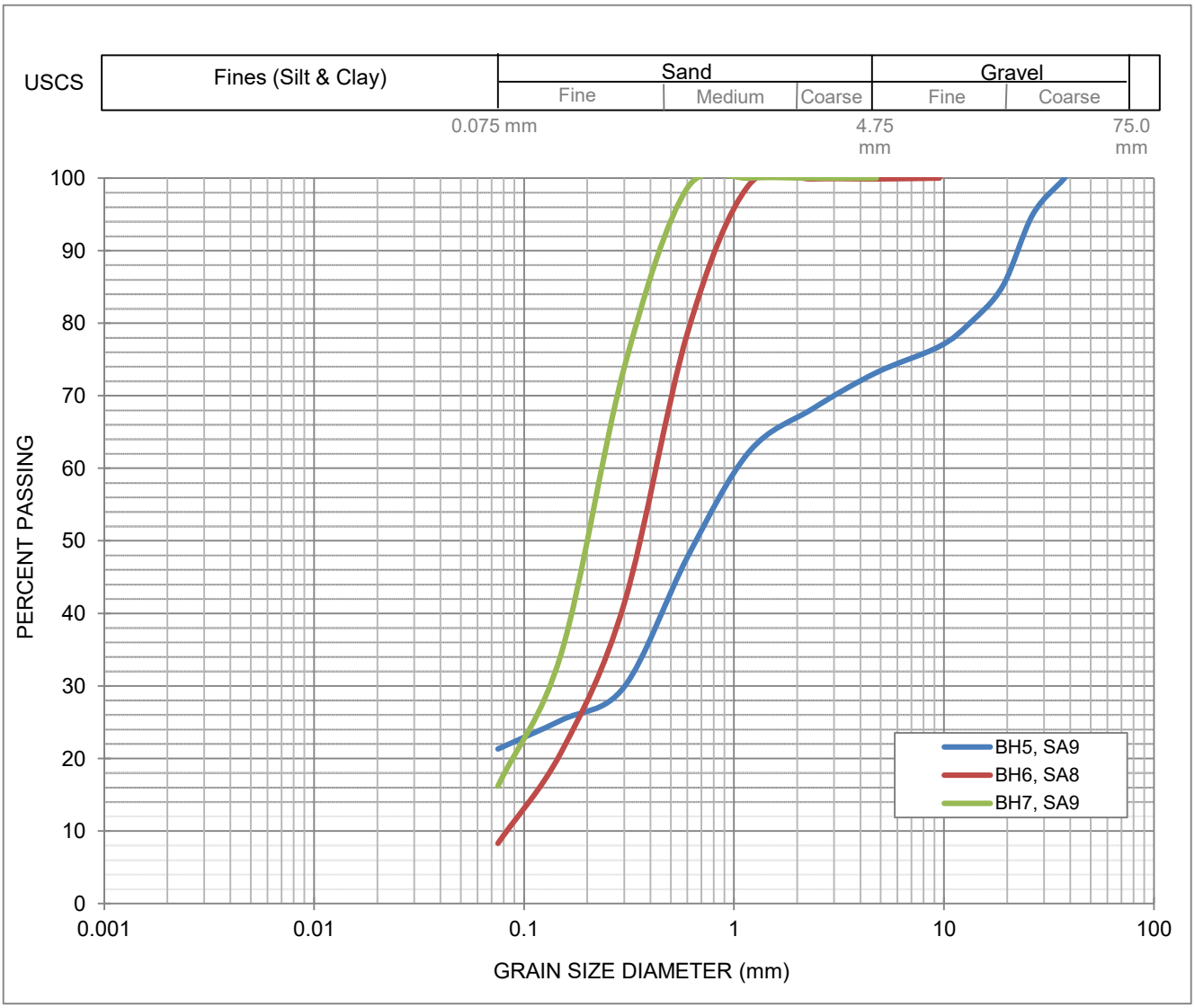


Particle Size Distribution
Results of Sieve Analysis

Project Name: Aggregate Pit Site **Date:** 19-Sep-19

Project Location: Part Lot 18, Concession 3 NRT
Geographic Township of North Dorchester **Project No.:** GE-00260

Sample ID	Unified Soil Classification				Moisture Content (%)
	Fines (Silt & Clay)	% Sand	% Gravel	% Cobbles	
BH5, SA9	21.3%	51.9%	26.8%	0.0%	8.7
BH6, SA8	8.3%	91.6%	0.1%	0.0%	16.6
BH7, SA9	16.2%	83.8%	0.0%	0.0%	16.3



APPENDIX C

ANALYTICAL LAB RESULTS

Your Project #: GE-00260
Site#: ONTARIO
Site Location: PIKE FARMS GRAVEL PIT
Your C.O.C. #: na

Attention: Rebecca Walker

LDS Consultants Inc
15875 Robins Hill Road
Unit 1
London, ON
CANADA N5V 0A5

Report Date: 2019/09/26
Report #: R5896771
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9Q4887
Received: 2019/09/20, 14:30

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	2	N/A	2019/09/26	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	2	N/A	2019/09/26	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	2	N/A	2019/09/24	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	2	N/A	2019/09/26	CAM SOP-00414	SM 23 2510 m
Dissolved Organic Carbon (DOC) (1)	2	N/A	2019/09/23	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3)	2	N/A	2019/09/24	CAM SOP 00102/00408/00447	SM 2340 B
Lab Filtered Metals by ICPMS	2	2019/09/23	2019/09/24	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	2	N/A	2019/09/26		
Anion and Cation Sum	2	N/A	2019/09/26		
Total Ammonia-N	2	N/A	2019/09/25	CAM SOP-00441	USGS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	2	N/A	2019/09/24	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH	2	2019/09/23	2019/09/26	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	2	N/A	2019/09/24	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2019/09/26		
Sat. pH and Langelier Index (@ 4C)	2	N/A	2019/09/26		
Sulphate by Automated Colourimetry	2	N/A	2019/09/24	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	2	N/A	2019/09/26		

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and

Your Project #: GE-00260
Site#: ONTARIO
Site Location: PIKE FARMS GRAVEL PIT
Your C.O.C. #: na

Attention: Rebecca Walker

LDS Consultants Inc
15875 Robins Hill Road
Unit 1
London, ON
CANADA N5V 0A5

Report Date: 2019/09/26
Report #: R5896771
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9Q4887
Received: 2019/09/20, 14:30

use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Christine Gripton, Senior Project Manager
Email: Christine.Gripton@bvlabs.com
Phone# (519)652-9444
==========
This report has been generated and distributed using a secure automated process.
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RCAP - COMPREHENSIVE (LAB FILTERED)

BV Labs ID		KVN232	KVN233		
Sampling Date		2019/09/20	2019/09/20		
COC Number		na	na		
	UNITS	BH2	BH6	RDL	QC Batch
Calculated Parameters					
Anion Sum	me/L	6.10	7.67	N/A	6347011
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	250	330	1.0	6347007
Calculated TDS	mg/L	330	410	1.0	6347015
Carb. Alkalinity (calc. as CaCO3)	mg/L	2.9	2.9	1.0	6347007
Cation Sum	me/L	6.48	8.16	N/A	6347011
Hardness (CaCO3)	mg/L	310	400	1.0	6347009
Ion Balance (% Difference)	%	3.00	3.09	N/A	6347010
Langelier Index (@ 20C)	N/A	1.05	1.12		6347013
Langelier Index (@ 4C)	N/A	0.804	0.873		6347014
Saturation pH (@ 20C)	N/A	7.05	6.85		6347013
Saturation pH (@ 4C)	N/A	7.30	7.10		6347014
Inorganics					
Total Ammonia-N	mg/L	0.17	0.11	0.050	6347604
Conductivity	umho/cm	570	700	1.0	6347669
Dissolved Organic Carbon	mg/L	1.6	1.5	0.50	6347050
Orthophosphate (P)	mg/L	<0.010	<0.010	0.010	6348115
pH	pH	8.10	7.97		6347670
Dissolved Sulphate (SO4)	mg/L	35	4.6	1.0	6348114
Alkalinity (Total as CaCO3)	mg/L	250	330	1.0	6347644
Dissolved Chloride (Cl-)	mg/L	14	13	1.0	6348108
Nitrite (N)	mg/L	<0.010	<0.010	0.010	6347620
Nitrate (N)	mg/L	<0.10	7.79	0.10	6347620
Nitrate + Nitrite (N)	mg/L	<0.10	7.79	0.10	6347620
Metals					
Dissolved Aluminum (Al)	ug/L	<5.0	<5.0	5.0	6347131
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	6347131
Dissolved Arsenic (As)	ug/L	<1.0	<1.0	1.0	6347131
Dissolved Barium (Ba)	ug/L	33	39	2.0	6347131
Dissolved Beryllium (Be)	ug/L	<0.50	<0.50	0.50	6347131
Dissolved Boron (B)	ug/L	12	<10	10	6347131
Dissolved Cadmium (Cd)	ug/L	<0.10	<0.10	0.10	6347131

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

RCAP - COMPREHENSIVE (LAB FILTERED)

BV Labs ID		KVN232	KVN233		
Sampling Date		2019/09/20	2019/09/20		
COC Number		na	na		
	UNITS	BH2	BH6	RDL	QC Batch
Dissolved Calcium (Ca)	ug/L	96000	120000	200	6347131
Dissolved Chromium (Cr)	ug/L	<5.0	<5.0	5.0	6347131
Dissolved Cobalt (Co)	ug/L	0.63	<0.50	0.50	6347131
Dissolved Copper (Cu)	ug/L	<1.0	1.1	1.0	6347131
Dissolved Iron (Fe)	ug/L	<100	<100	100	6347131
Dissolved Lead (Pb)	ug/L	<0.50	<0.50	0.50	6347131
Dissolved Magnesium (Mg)	ug/L	18000	24000	50	6347131
Dissolved Manganese (Mn)	ug/L	600	48	2.0	6347131
Dissolved Molybdenum (Mo)	ug/L	1.9	0.80	0.50	6347131
Dissolved Nickel (Ni)	ug/L	1.2	<1.0	1.0	6347131
Dissolved Phosphorus (P)	ug/L	<100	<100	100	6347131
Dissolved Potassium (K)	ug/L	1000	890	200	6347131
Dissolved Selenium (Se)	ug/L	<2.0	<2.0	2.0	6347131
Dissolved Silicon (Si)	ug/L	5000	5400	50	6347131
Dissolved Silver (Ag)	ug/L	<0.10	<0.10	0.10	6347131
Dissolved Sodium (Na)	ug/L	5000	4900	100	6347131
Dissolved Strontium (Sr)	ug/L	140	130	1.0	6347131
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	0.050	6347131
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	6347131
Dissolved Uranium (U)	ug/L	1.9	0.39	0.10	6347131
Dissolved Vanadium (V)	ug/L	0.65	<0.50	0.50	6347131
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6347131

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

GENERAL COMMENTS

Results relate only to the items tested.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6347050	KRM	Matrix Spike	Dissolved Organic Carbon	2019/09/23		89	%	80 - 120
6347050	KRM	Spiked Blank	Dissolved Organic Carbon	2019/09/23		97	%	80 - 120
6347050	KRM	Method Blank	Dissolved Organic Carbon	2019/09/23	<0.50		mg/L	
6347050	KRM	RPD	Dissolved Organic Carbon	2019/09/23	1.7		%	20
6347131	PBA	Matrix Spike [KVN232-01]	Dissolved Aluminum (Al)	2019/09/24		104	%	80 - 120
			Dissolved Antimony (Sb)	2019/09/24		104	%	80 - 120
			Dissolved Arsenic (As)	2019/09/24		102	%	80 - 120
			Dissolved Barium (Ba)	2019/09/24		98	%	80 - 120
			Dissolved Beryllium (Be)	2019/09/24		105	%	80 - 120
			Dissolved Boron (B)	2019/09/24		103	%	80 - 120
			Dissolved Cadmium (Cd)	2019/09/24		104	%	80 - 120
			Dissolved Calcium (Ca)	2019/09/24		NC	%	80 - 120
			Dissolved Chromium (Cr)	2019/09/24		97	%	80 - 120
			Dissolved Cobalt (Co)	2019/09/24		102	%	80 - 120
			Dissolved Copper (Cu)	2019/09/24		103	%	80 - 120
			Dissolved Iron (Fe)	2019/09/24		103	%	80 - 120
			Dissolved Lead (Pb)	2019/09/24		102	%	80 - 120
			Dissolved Magnesium (Mg)	2019/09/24		100	%	80 - 120
			Dissolved Manganese (Mn)	2019/09/24		NC	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/09/24		105	%	80 - 120
			Dissolved Nickel (Ni)	2019/09/24		98	%	80 - 120
			Dissolved Phosphorus (P)	2019/09/24		104	%	80 - 120
			Dissolved Potassium (K)	2019/09/24		105	%	80 - 120
			Dissolved Selenium (Se)	2019/09/24		103	%	80 - 120
			Dissolved Silicon (Si)	2019/09/24		104	%	80 - 120
			Dissolved Silver (Ag)	2019/09/24		102	%	80 - 120
			Dissolved Sodium (Na)	2019/09/24		101	%	80 - 120
			Dissolved Strontium (Sr)	2019/09/24		98	%	80 - 120
			Dissolved Thallium (Tl)	2019/09/24		101	%	80 - 120
			Dissolved Titanium (Ti)	2019/09/24		104	%	80 - 120
			Dissolved Uranium (U)	2019/09/24		101	%	80 - 120
			Dissolved Vanadium (V)	2019/09/24		98	%	80 - 120
			Dissolved Zinc (Zn)	2019/09/24		102	%	80 - 120
6347131	PBA	Spiked Blank	Dissolved Aluminum (Al)	2019/09/24		103	%	80 - 120
			Dissolved Antimony (Sb)	2019/09/24		99	%	80 - 120
			Dissolved Arsenic (As)	2019/09/24		100	%	80 - 120
			Dissolved Barium (Ba)	2019/09/24		93	%	80 - 120
			Dissolved Beryllium (Be)	2019/09/24		101	%	80 - 120
			Dissolved Boron (B)	2019/09/24		99	%	80 - 120
			Dissolved Cadmium (Cd)	2019/09/24		99	%	80 - 120
			Dissolved Calcium (Ca)	2019/09/24		107	%	80 - 120
			Dissolved Chromium (Cr)	2019/09/24		96	%	80 - 120
			Dissolved Cobalt (Co)	2019/09/24		102	%	80 - 120
			Dissolved Copper (Cu)	2019/09/24		101	%	80 - 120
			Dissolved Iron (Fe)	2019/09/24		104	%	80 - 120
			Dissolved Lead (Pb)	2019/09/24		97	%	80 - 120
			Dissolved Magnesium (Mg)	2019/09/24		106	%	80 - 120
			Dissolved Manganese (Mn)	2019/09/24		100	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/09/24		99	%	80 - 120
			Dissolved Nickel (Ni)	2019/09/24		98	%	80 - 120
			Dissolved Phosphorus (P)	2019/09/24		120	%	80 - 120
			Dissolved Potassium (K)	2019/09/24		106	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Selenium (Se)	2019/09/24		101	%	80 - 120
			Dissolved Silicon (Si)	2019/09/24		105	%	80 - 120
			Dissolved Silver (Ag)	2019/09/24		97	%	80 - 120
			Dissolved Sodium (Na)	2019/09/24		104	%	80 - 120
			Dissolved Strontium (Sr)	2019/09/24		98	%	80 - 120
			Dissolved Thallium (Tl)	2019/09/24		98	%	80 - 120
			Dissolved Titanium (Ti)	2019/09/24		104	%	80 - 120
			Dissolved Uranium (U)	2019/09/24		94	%	80 - 120
			Dissolved Vanadium (V)	2019/09/24		98	%	80 - 120
			Dissolved Zinc (Zn)	2019/09/24		100	%	80 - 120
6347131	PBA	Method Blank	Dissolved Aluminum (Al)	2019/09/24	<5.0		ug/L	
			Dissolved Antimony (Sb)	2019/09/24	<0.50		ug/L	
			Dissolved Arsenic (As)	2019/09/24	<1.0		ug/L	
			Dissolved Barium (Ba)	2019/09/24	<2.0		ug/L	
			Dissolved Beryllium (Be)	2019/09/24	<0.50		ug/L	
			Dissolved Boron (B)	2019/09/24	<10		ug/L	
			Dissolved Cadmium (Cd)	2019/09/24	<0.10		ug/L	
			Dissolved Calcium (Ca)	2019/09/24	<200		ug/L	
			Dissolved Chromium (Cr)	2019/09/24	<5.0		ug/L	
			Dissolved Cobalt (Co)	2019/09/24	<0.50		ug/L	
			Dissolved Copper (Cu)	2019/09/24	<1.0		ug/L	
			Dissolved Iron (Fe)	2019/09/24	<100		ug/L	
			Dissolved Lead (Pb)	2019/09/24	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2019/09/24	<50		ug/L	
			Dissolved Manganese (Mn)	2019/09/24	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2019/09/24	<0.50		ug/L	
			Dissolved Nickel (Ni)	2019/09/24	<1.0		ug/L	
			Dissolved Phosphorus (P)	2019/09/24	<100		ug/L	
			Dissolved Potassium (K)	2019/09/24	<200		ug/L	
			Dissolved Selenium (Se)	2019/09/24	<2.0		ug/L	
			Dissolved Silicon (Si)	2019/09/24	<50		ug/L	
			Dissolved Silver (Ag)	2019/09/24	<0.10		ug/L	
			Dissolved Sodium (Na)	2019/09/24	<100		ug/L	
			Dissolved Strontium (Sr)	2019/09/24	<1.0		ug/L	
			Dissolved Thallium (Tl)	2019/09/24	<0.050		ug/L	
			Dissolved Titanium (Ti)	2019/09/24	<5.0		ug/L	
			Dissolved Uranium (U)	2019/09/24	<0.10		ug/L	
			Dissolved Vanadium (V)	2019/09/24	<0.50		ug/L	
			Dissolved Zinc (Zn)	2019/09/24	<5.0		ug/L	
6347131	PBA	RPD [KVN232-01]	Dissolved Aluminum (Al)	2019/09/24	NC		%	20
			Dissolved Antimony (Sb)	2019/09/24	NC		%	20
			Dissolved Arsenic (As)	2019/09/24	NC		%	20
			Dissolved Barium (Ba)	2019/09/24	0.34		%	20
			Dissolved Beryllium (Be)	2019/09/24	NC		%	20
			Dissolved Boron (B)	2019/09/24	2.8		%	20
			Dissolved Cadmium (Cd)	2019/09/24	NC		%	20
			Dissolved Calcium (Ca)	2019/09/24	0.19		%	20
			Dissolved Chromium (Cr)	2019/09/24	NC		%	20
			Dissolved Cobalt (Co)	2019/09/24	6.3		%	20
			Dissolved Copper (Cu)	2019/09/24	NC		%	20
			Dissolved Iron (Fe)	2019/09/24	NC		%	20
			Dissolved Lead (Pb)	2019/09/24	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Magnesium (Mg)	2019/09/24	2.8		%	20
			Dissolved Manganese (Mn)	2019/09/24	2.7		%	20
			Dissolved Molybdenum (Mo)	2019/09/24	0.96		%	20
			Dissolved Nickel (Ni)	2019/09/24	18		%	20
			Dissolved Phosphorus (P)	2019/09/24	NC		%	20
			Dissolved Potassium (K)	2019/09/24	3.1		%	20
			Dissolved Selenium (Se)	2019/09/24	NC		%	20
			Dissolved Silicon (Si)	2019/09/24	1.4		%	20
			Dissolved Silver (Ag)	2019/09/24	NC		%	20
			Dissolved Sodium (Na)	2019/09/24	0.96		%	20
			Dissolved Strontium (Sr)	2019/09/24	3.1		%	20
			Dissolved Thallium (Tl)	2019/09/24	NC		%	20
			Dissolved Titanium (Ti)	2019/09/24	NC		%	20
			Dissolved Uranium (U)	2019/09/24	1.4		%	20
			Dissolved Vanadium (V)	2019/09/24	4.3		%	20
			Dissolved Zinc (Zn)	2019/09/24	NC		%	20
6347604	MT4	Matrix Spike	Total Ammonia-N	2019/09/25		100	%	75 - 125
6347604	MT4	Spiked Blank	Total Ammonia-N	2019/09/25		102	%	80 - 120
6347604	MT4	Method Blank	Total Ammonia-N	2019/09/25	<0.050		mg/L	
6347604	MT4	RPD	Total Ammonia-N	2019/09/25	4.9		%	20
6347620	C_N	Matrix Spike	Nitrite (N)	2019/09/24		120	%	80 - 120
			Nitrate (N)	2019/09/24		90	%	80 - 120
6347620	C_N	Spiked Blank	Nitrite (N)	2019/09/24		102	%	80 - 120
			Nitrate (N)	2019/09/24		96	%	80 - 120
6347620	C_N	Method Blank	Nitrite (N)	2019/09/24	<0.010		mg/L	
			Nitrate (N)	2019/09/24	<0.10		mg/L	
6347620	C_N	RPD	Nitrite (N)	2019/09/24	NC		%	20
			Nitrate (N)	2019/09/24	1.6		%	20
6347644	NYS	Spiked Blank	Alkalinity (Total as CaCO3)	2019/09/26		98	%	85 - 115
6347644	NYS	Method Blank	Alkalinity (Total as CaCO3)	2019/09/26	<1.0		mg/L	
6347644	NYS	RPD [KVN233-01]	Alkalinity (Total as CaCO3)	2019/09/26	0.72		%	20
6347669	NYS	Spiked Blank	Conductivity	2019/09/26		101	%	85 - 115
6347669	NYS	Method Blank	Conductivity	2019/09/26	<1.0		umho/cm	
6347669	NYS	RPD [KVN233-01]	Conductivity	2019/09/26	0.14		%	25
6347670	NYS	Spiked Blank	pH	2019/09/26		102	%	98 - 103
6347670	NYS	RPD [KVN233-01]	pH	2019/09/26	0.13		%	N/A
6348108	DRM	Matrix Spike [KVN232-01]	Dissolved Chloride (Cl-)	2019/09/24		98	%	80 - 120
6348108	DRM	Spiked Blank	Dissolved Chloride (Cl-)	2019/09/24		103	%	80 - 120
6348108	DRM	Method Blank	Dissolved Chloride (Cl-)	2019/09/24	<1.0		mg/L	
6348108	DRM	RPD [KVN232-01]	Dissolved Chloride (Cl-)	2019/09/24	0.81		%	20
6348114	ADB	Matrix Spike [KVN232-01]	Dissolved Sulphate (SO4)	2019/09/24		NC	%	75 - 125
6348114	ADB	Spiked Blank	Dissolved Sulphate (SO4)	2019/09/24		100	%	80 - 120
6348114	ADB	Method Blank	Dissolved Sulphate (SO4)	2019/09/24	<1.0		mg/L	
6348114	ADB	RPD [KVN232-01]	Dissolved Sulphate (SO4)	2019/09/24	0.10		%	20
6348115	ADB	Matrix Spike [KVN232-01]	Orthophosphate (P)	2019/09/24		105	%	75 - 125
6348115	ADB	Spiked Blank	Orthophosphate (P)	2019/09/24		100	%	80 - 120
6348115	ADB	Method Blank	Orthophosphate (P)	2019/09/24	<0.010		mg/L	

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6348115	ADB	RPD [KVN232-01]	Orthophosphate (P)	2019/09/24	NC		%	25

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

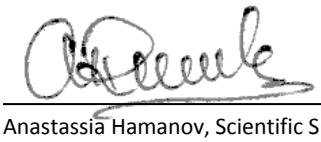
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

BUREAU VERITAS

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/5

CHAIN OF CUSTODY RECORD

Page _____ of _____

Invoice Information
Company Name: LDS Consultants
Contact Name: Rebecca Walker
Address:
Phone: Fax:
Email: Rebecca.Walker@LDSConsultants.ca

Report Information (if differs from invoice)
Company Name:
Contact Name:
Address:
Phone: Fax:
Email:

Project Information (where applicable)
Quotation #:
P.O. #/ AFE#:
Project #: GE-00260
Site Location: Pike Farms Gravel Pit
Site #:
Site Location Province: Ontario
Sampled By: Rob Walker

Turnaround Time (TAT) Required
☑ Regular TAT (5-7 days) Most analyses
PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Rush TAT (Surcharges will be applied)
☐ 1 Day ☐ 2 Days ☐ 3-4 Days
Date Required:
Rush Confirmation #:

MDE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS LABORATORIES' DRINKING WATER CHAIN OF CUSTODY

Regulation 153
☐ Table 1 ☐ Res/Park ☐ Med/ Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/ Other
☐ Table ____
FOR RSC (PLEASE CIRCLE) Y / N

Other Regulations
☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☐ PWQO Region
☐ Other (Specify)
☐ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

LABORATORY USE ONLY
CUSTODY SEAL Y / N (Present / Intact)
COOLER TEMPERATURES: 16, 15, 16°C
11/13/13
COOLING MEDIA PRESENT: (Y) / N

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	General Chemistry							HOLD- DO NOT ANALYZE	COMMENTS
1	BH 2	2019/09/20	PM	water	3								✓								
2	BH 6	2019/09/20	PM	water	3								✓								
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

20-Sep-19 14:30
Christine Gripton
B9Q4887
WVL ENV-1242

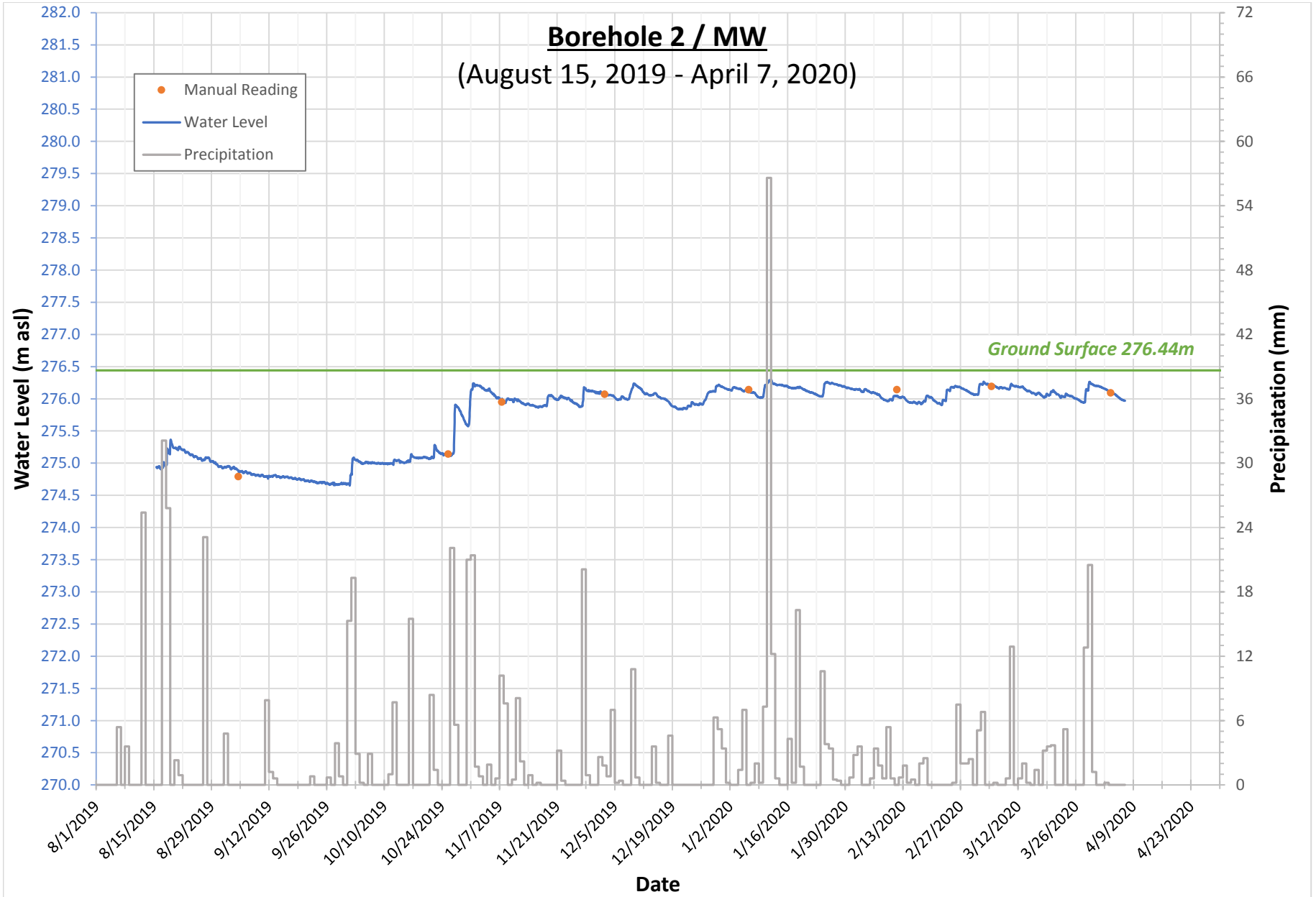
REC'D IN LONDON

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	BV JOB #
Rob Walker / Rob Walker	2019/09/20	14:30	C Gripton / C Gripton	2019/09/20	14:30	
			Andrea Sukkiman / Andrea Sukkiman	2019/09/20	18:30	

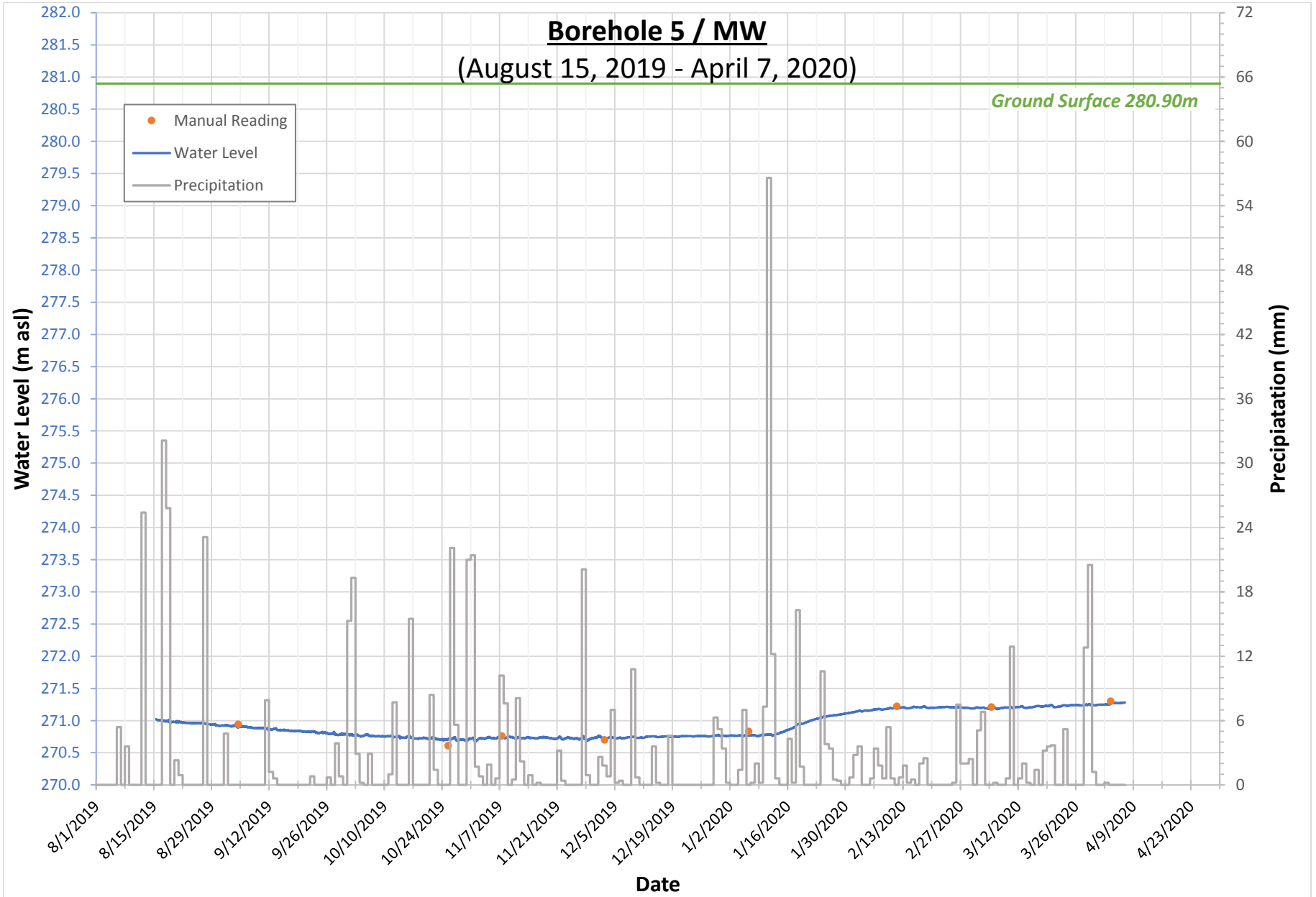
WBH 149600

APPENDIX D

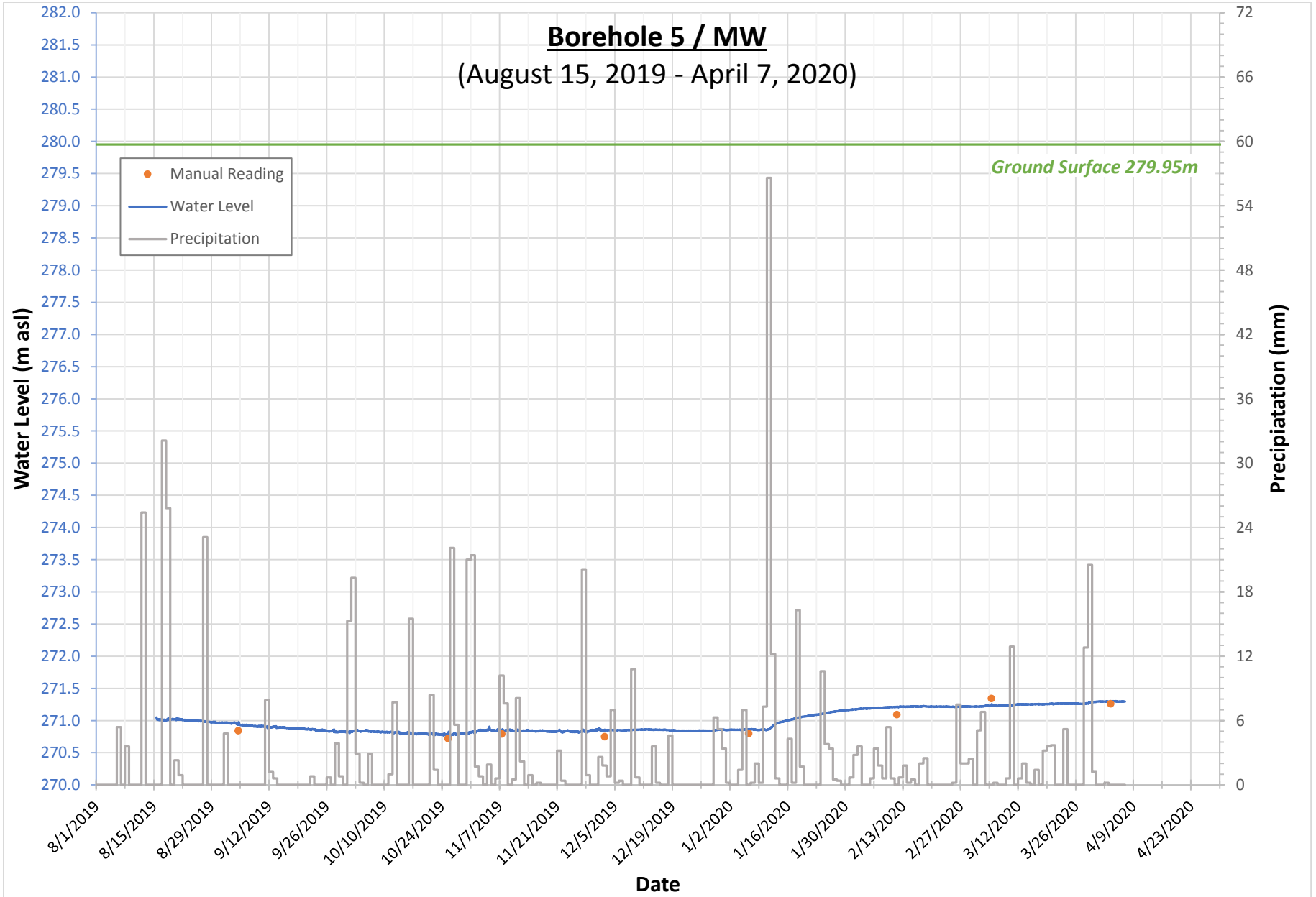
GROUNDWATER HYDROGRAPHS



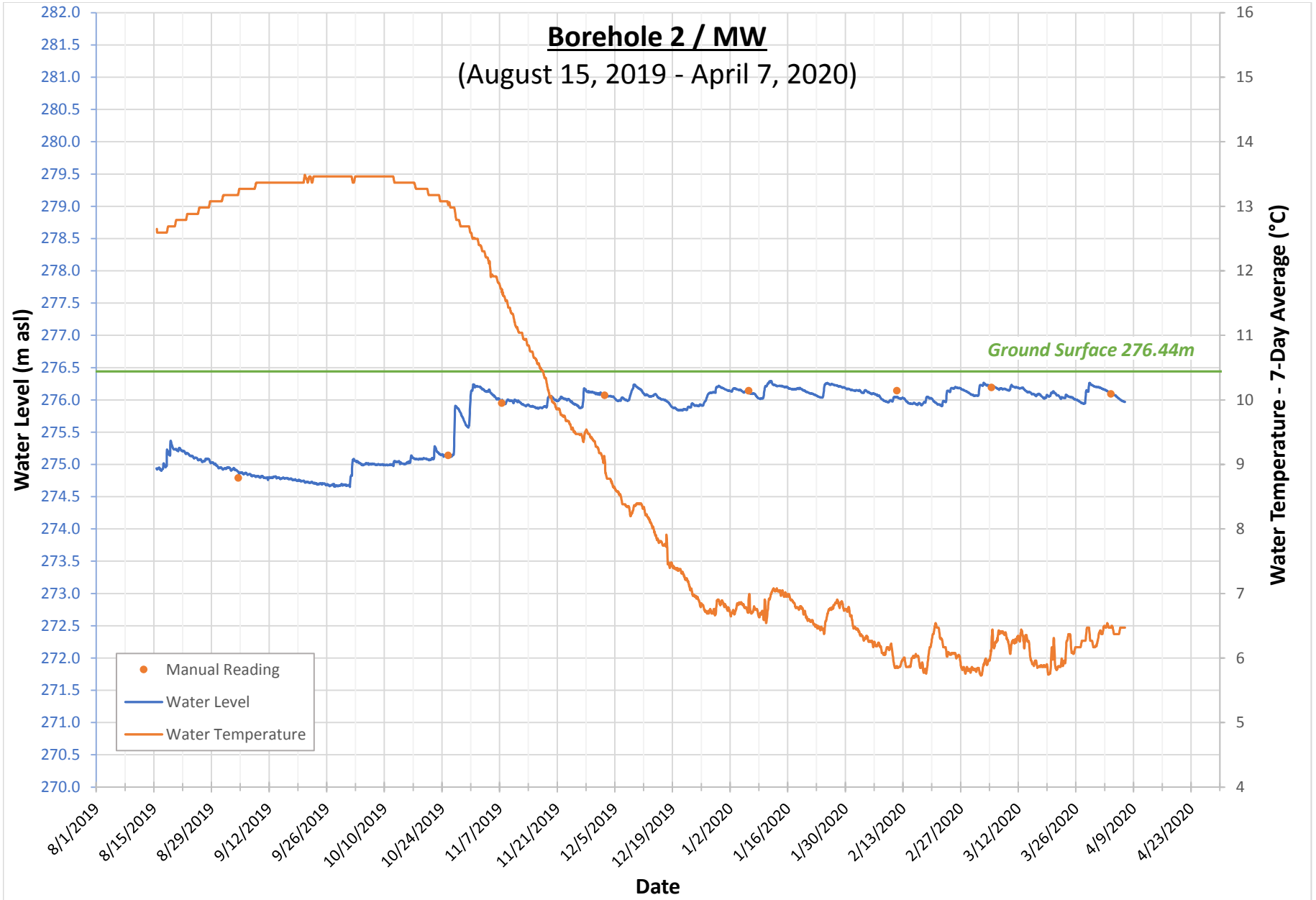
1. Water Levels collected using Onset Hobo U20L Unit. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London International Airport.
2. Precipitation data sourced from Environment Canada London Internation Airport Weather Station.



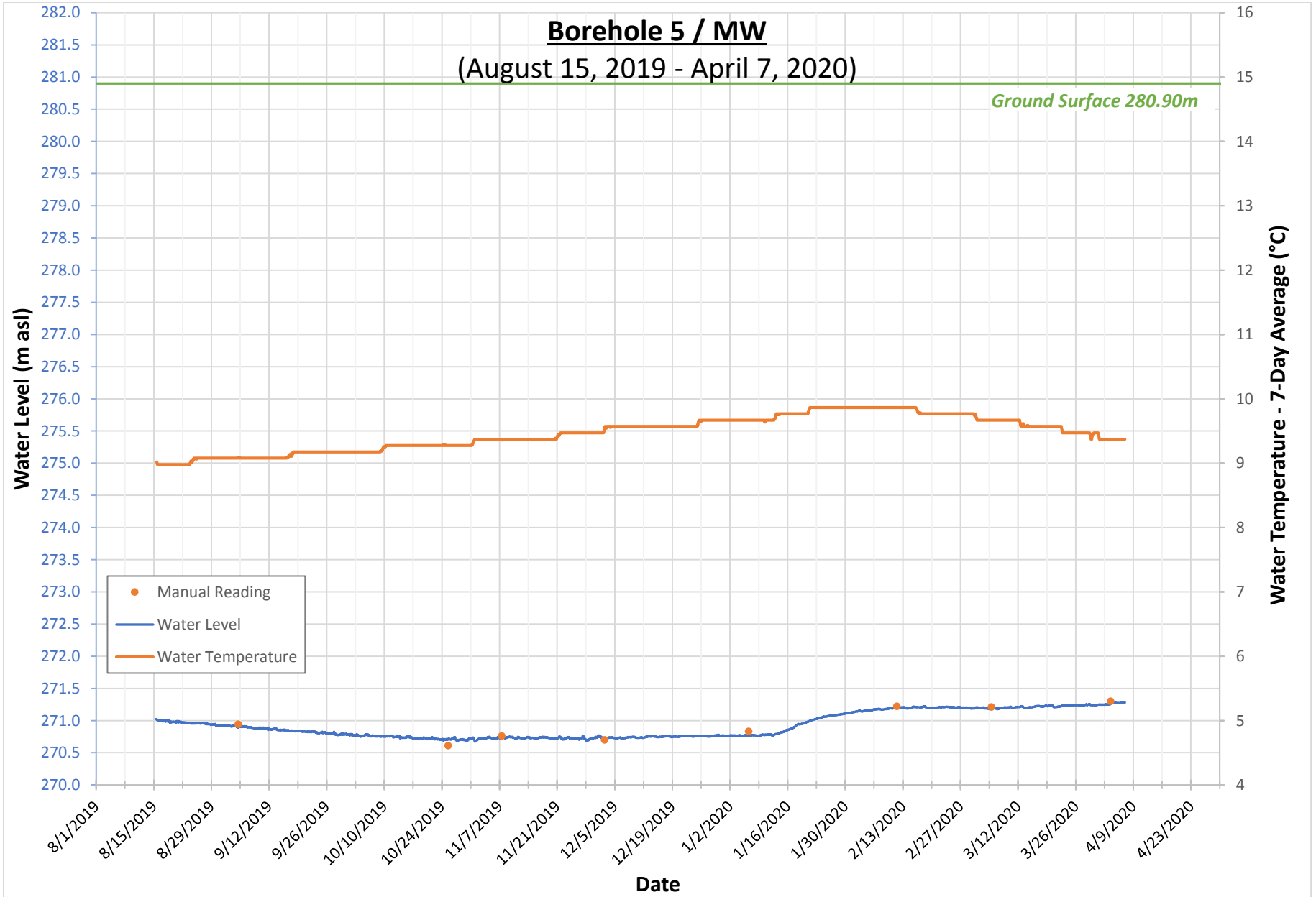
1. Water Levels collected using Onset Hobo U20L Unit. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London International Airport.
2. Precipitation data sourced from Environment Canada London Internation Airport Weather Station.



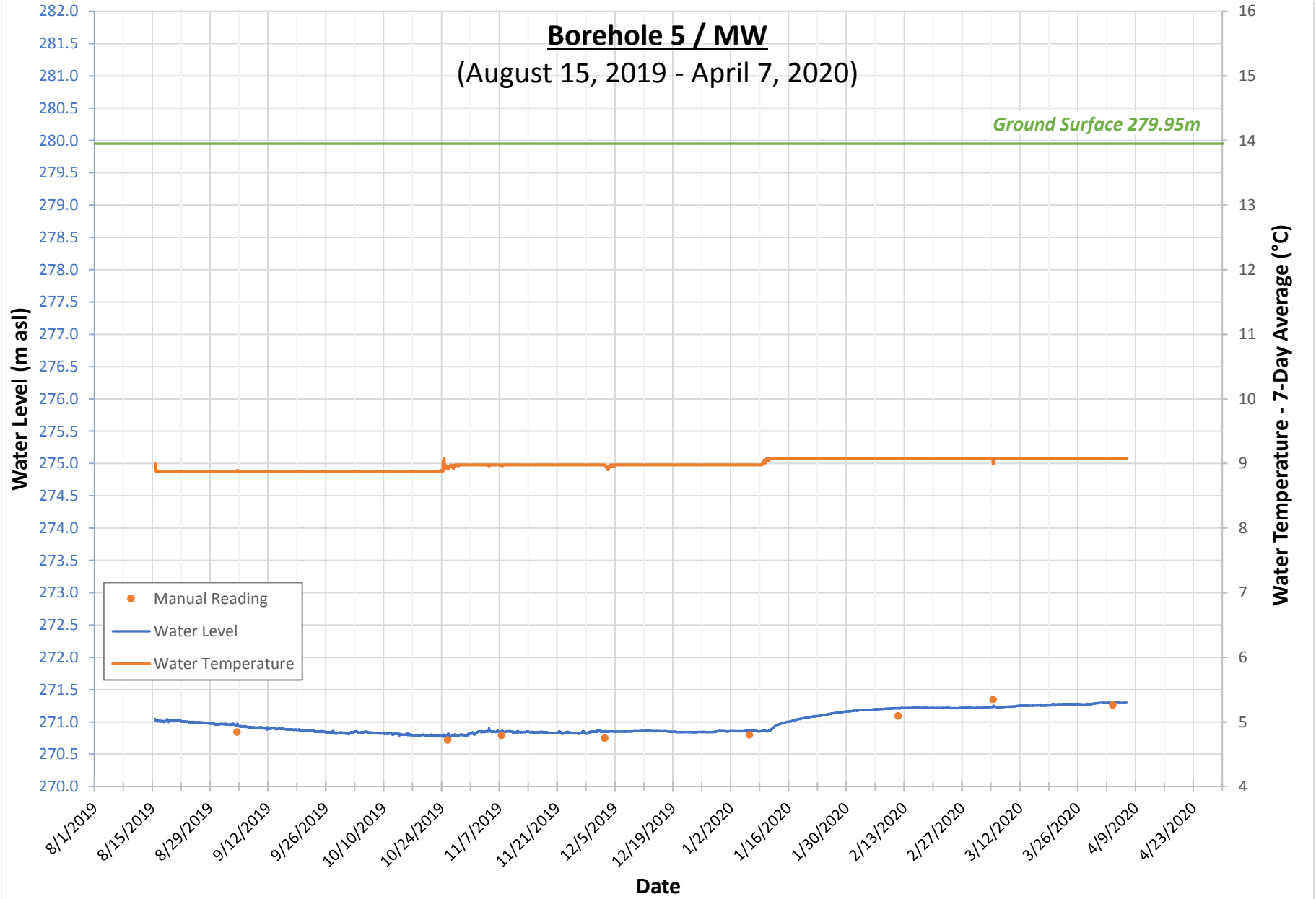
1. Water Levels collected using Onset Hobo U20L Unit. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London International Airport.
2. Precipitation data sourced from Environment Canada London Internation Airport Weather Station.



1. Water Levels collected using Onset Hobo U20L Unit. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London International Airport.
2. Precipitation data sourced from Environment Canada London Internation Airport Weather Station.



1. Water Levels collected using Onset Hobo U20L Unit. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London International Airport.
2. Precipitation data sourced from Environment Canada London Internation Airport Weather Station.



1. Water Levels collected using Onset Hobo U20L Unit. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London International Airport.
2. Precipitation data sourced from Environment Canada London Internation Airport Weather Station.

APPENDIX E

MECP WELL RECORD REVIEW

SUMMARY OF MECP WELL RECORD SEARCH

MECP Well ID	Completion Date	Type	Depth (m)	Water Found (m)	Static Level (m)	Pump Rate (L/min)	Northing	Easting
4703123	01/03/1971	Water Supply	9.4	4.9	4.9	19.0	4766238.00	499433.70
4706154	29/10/1987	Water Supply	109.7	54.9	13.7	11.4	4766233.00	499573.70
4706929	12/09/1991	Water Supply	107.3	107.3	30.5	57.0	4766459.00	499650.70
4707391	12/06/1995	Water Supply	20.1	18.9	5.2	38.0	4765619.00	499659.70
4707408	20/06/1995	Water Supply	21.3	19.5	5.8	38.0	4765264.00	499027.70
4708709	26/06/2003	Water Supply	18.3	18.0	4.3	76.0	4766162.00	499166.00
7248186	17/08/2015	Water Supply	29.6	18.9	9.2	38.0	4765724.00	499856.00
4708986	28/01/2005	Observation Wells	8.5	*NR*	*NR*	*NR*	4765859.00	498965.00
4704030	01/08/1974	Abandoned-Supply	27.4	20.4	6.7	*NR*	4766344.00	499443.70
4708621	24/01/2003	Abandoned-Other	*NR*	*NR*	*NR*	*NR*	4766400.00	499725.00
7166212	20/07/2011	Abandoned-Other	*NR*	*NR*	*NR*	*NR*	4766201.00	499560.00
7166215	20/07/2011	Abandoned-Other	*NR*	*NR*	*NR*	*NR*	4766201.00	499560.00
7283858	28/02/2016		*NR*	*NR*	*NR*	*NR*	4765239.00	499051.00

Source: MECP Online Interactive Database, www.ontario.ca/environment-and-energy/map-well-records, updated January 24, 2020

GE-00260

Ontario — Ministry of the Environment and Climate Change

Well Record for Well Cluster – Part 1 of 3

(Only for Multiple Test Holes or Dewatering Wells)

Regulation 903 Ontario Water Resources Act

All measurements recorded in: ☐ Metric ☒ Imperial

Follow instructions on the front and back of this form. Print or Type

Well Tag No. of Deepest Well: *(Print Well Tag No.)* A273529

Well No. on Drawing of Deepest Well:

☐ Dewatering wells
☒ Test holes
No. of wells reported 6

Page 1 of 2

Well Cluster Location Information

Address of Well Location (Street Number(s)/Name(s), RR, if available)	Lot(s)	Concession(s)	Geographic Township	County/District/Upper Tier Municipality
6693 Gore Road (Cty Rd 25)				Middlesex

City, Town, Village or Hamlet	Province	GPS Unit Make	Model	Unit Mode of Operation
Thames Centre	Ontario			☒ Undifferentiated ☐ Averaged ☐ Differentiated, specify:

Mandatory Attachments/Additional Information

☒ Land Owner Consent Form must be attached.
☒ Detailed Drawing of All Well Locations must be attached.

I, the person constructing the well, will promptly submit to the Director, on request, any additional information in my custody or control related to any well in the well cluster that I have constructed.

Signature of Technician/Contractor — Date (yyyy/mm/dd): 2019/07/22

Well Details

Well # on Drawing	UTM Coordinates Zone	Easting	Northing	Hole Depth (m/ft)	Hole Diameter (cm/in)	Method of Construction	Casing Material; Diameter (cm/in)	Casing (m/ft) From	Casing (m/ft) To	Screen Interval (m/ft) From	Screen Interval (m/ft) To	Annular Space Material (m/ft) From	Annular Space Material (m/ft) To	Annular Space Material: Material:	Overburden/Bedrock or Abandonment Filing Material Intervals (m/ft)	Static Water Level (m/ft)	Date of Completion (yyyy/mm/dd)
1	17	499131	4763126	35	8	rotary	2"	+5	-30	30	35	0	29	Bent	0-2' Topsoil	29'	2019/07/10
												29	35	sand	2' 35' sand & gravel		
2	17	499219	4763135	35	8	rotary	2"	+5	-30	30	35	0	26	Bent	0-2' Topsoil	30'	2019/07/10
												26	35	Sand	2-35 Sand & gravel		
3	17	499251	4763137	35	8	rotary	2"	+5	-30	30	35	0	26	Bent	0-2' Top soil	31'	2019/07/10
												26	35	Sand	2-35 Sand & gravel		
4	17	499191	4763141	25	8	rotary	2"	+5	-18'	18	23	0	18	Bent	0-2' Topsoil		2019/07/10
												18	25	sand	2'-18' brown sand & gravel	18'	
															18'-22.5' brown sand		
															22.5-25' clay & some gravel		

LONDON SOIL TEST LTD.
712078 Southgate Sdrd. 71
Dundalk, ON N0C 1B0
519-455-5777 info@londonsoil.com

Contractor Information

Business Address (Street Number/Name, RR)	Municipality	Province

Well Contractor's Licence No.	Business E-mail Address
7190	

Name of Well Technician (First Name, Last Name)	Well Technician's Licence No.	Signature of Well Technician	Date Submitted (yyyy/mm/dd)
[illegible] Tobias	2970		2019/08/13

Date First Well in Cluster Constructed or Abandoned (yyyy/mm/dd)	Date Last Well in Cluster Completed (yyyy/mm/dd)
2019/07/10	2019/07/22

Well Abandonment

Person Abandoning the Wells:

Name _____
(Print or Type) - See instruction 11 on the back of this form

Ministry Use Only

Date Received (yyyy/mm/dd)	Audit No
	L 37595

Comments

1991E (2015/10)

Well Owner's Copy

LDS MONITORING WELLS

Ontario — Ministry of the Environment and Climate Change

Well Record for Well Cluster – Part 1 of 3

(Only for Multiple Test Holes or Dewatering Wells)

Regulation 903 Ontario Water Resources Act

Page 2 of 2

All measurements recorded in: ☐ Metric ☑ Imperial

Follow instructions on the front and back of this form. Print or Type

Well Tag No. of Deepest Well: *(Print Well Tag No.)* A273529

Well No. on Drawing of Deepest Well:

☐ Dewatering wells ☑ Test holes

No. of wells reported 6

Well Cluster Location Information

Address of Well Location (Street Number(s)/Name(s), RR, if available)	Lot(s)	Concession(s)	Geographic Township	County/District/Upper Tier Municipality
16693 Gore Rd (Cty Rd 25)				Middlesex

City, Town, Village or Hamlet	Province	GPS Unit Make	Model	Unit Mode of Operation
Thames Centre	Ontario			☑ Undifferentiated ☐ Averaged ☐ Differentiated, specify:

Mandatory Attachments/Additional Information

☒ Land Owner Consent Form must be attached.

☒ Detailed Drawing of All Well Locations must be attached.

I, the person constructing the well, will promptly submit to the Director, on request, any additional information in my custody or control related to any well in the well cluster that I have constructed.

Signature of Technician/Contractor — Date (yyyy/mm/dd) 2019/07/22

Well Details

Well # on Drawing	UTM Coordinates Zone	Easting	Northing	Hole Depth (m/ft)	Hole Diameter (cm/in)	Method of Construction	Casing Material; Diameter (cm/in)	Casing (m/ft) From	Casing (m/ft) To	Screen Interval (m/ft) From	Screen Interval (m/ft) To	Annular Space Material (m/ft) From	Annular Space Material (m/ft) To	Annular Space Material: Material:	Overburden/Bedrock or Abandonment Filing Material Intervals (m/ft)	Static Water Level (m/ft)	Date of Completion (yyyy/mm/dd)
5	17	493818	4763161	15	8"	Rotary	2"	+5	-5'	5'	10'	0	4	Bentonite	0-1 Topsoil	dry	2019/07/22
							4"	-6"	2'			4'	10.5	sand	1-7' silty clay to gravel		
												10.5'	15	Bentonite	7-8 sand gravel		
															8-15 grey hard silt till, trace sand & gravel		
6	17	493128	4763697	10'	8'	Rotary	2"	+5'	-5'	5'	10'	0	4	Bentonite	0-1.5' Topsoil	5	2019/07/22
							4"	1.5'	3'			4	10	sand	1.5-5' Brown wet silt/sand		
															5'-10' coarse sand (SGW)		

LONDON SOIL TEST LTD.
712078 Southgate Sdrd. 71
Dundalk, ON N0C 1B0
519-455-5777 info@londonsoil.com

Information

Business Address (Street Number/Name, RR)	Municipality	Province

Well Contractor's Licence No.	Business E-mail Address
7198	

Name of Well Technician (First Name, Last Name)	Well Technician's Licence No.	Signature of Well Technician	Date Submitted (yyyy/mm/dd)
Trevor Ross	2970		2019/08/13

Date First Well in Cluster Constructed or Abandoned (yyyy/mm/dd)	Date Last Well in Cluster Completed (yyyy/mm/dd)
2019/07/10	2019/07/22

Well Abandonment

Person Abandoning the Wells:

Name _____ (Print or Type) - See Instruction 11 on the back of this form

Ministry Use Only

Date Received (yyyy/mm/dd)	Audit No
	C 45003

Comments

1991E (2015/10)

Well Owner's Copy

LDS MONITORING WELLS

LDS
MONITORING
WELLS

Ontario

Ministry of the Environment
Conservation and Parks

Well Record for Well Cluster – Part 2 of 3
Land Owner Consent

This form is to be completed by the person who constructs or abandons test holes or dewatering wells that form all or part of a well cluster. If this form is being used to report any well abandonment, these wells must have been previously reported as part of a single well cluster.

Note: For well cluster records, only the owner of the land on which the wells are situated are to give written consent. If the well purchaser (e.g. a consultant who hires the driller) is not the owner of the land, then the well purchaser cannot sign the consent form.

By signing this form, land owners are providing consent to use one well record to report a well cluster of test holes or dewatering wells in accordance with section 16.4 of Regulation 903 made under the *Ontario Water Resources Act*.

This completed **Well Record for Well Cluster Part 2 – Land Owner Consent** must be attached to Parts 1 and 3.

* Please PRINT if completing by hand.

Well Tag Number: # A273529

"Well Record for Well Cluster" Audit Number: # C37595, C45003

Well # on Detailed Drawing	Property Location Description	Land Owner's Name	Signature of Land Owner	Date Signed (yyyy/mm/dd)
MW1	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
MW2	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
MW3	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
MW4	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
MW5	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
MW6	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
MW7	6693 Gore Road (County Road 25) Thames Centre, Ontario	Thames Valley Aggregates 75 Blackfriars Street London, Ontario N6H 1K8		2019/07/25
Note: Well locations shown on attached plan.				

Ministry's Copy

A273529-

LDS
MONITORING
WELLS

APPENDIX F

WELL SURVEY QUESTIONNAIRES

December 3, 2019
LDS File: GE-00260

Attention: **House Owner / Resident**

Reference: **REQUEST FOR INFORMATION**
WELL SURVEY QUESTIONNAIRE

LDS Consultants Inc. (LDS) has been retained to prepare background hydrogeological information for a proposed aggregate pit for the property located at the southeast corner of Hunt Road and Gore Road in Thames Centre, Ontario.

As part of the due diligence work required for the proposed development, we are collecting information regarding shallow wells and shallow groundwater conditions which may be present in proximity to the project site, to supplement the Ministry of Environment Conservation and Parks (MECP) well records and our site investigation work.

You are kindly requested to fill-in the attached Questionnaire to the best of your knowledge. Please return the completed forms to LDS at your earliest convenience. The form can be sent via email, to Rebecca.Walker@LDSconsultants.ca. It is noted that this is our second attempt to contact you.

Your participation in completing this survey is greatly appreciated, and will assist LDS in the preparation of the Hydrogeological Report, to ensure that suitable recommendations are included in our report to ensure that design and construction for the proposed development incorporates suitable measures to minimize potential impacts to your water supply.

If you have any questions about this request, or would like to provide the requested information over the phone (rather than completing the attached form), please don't hesitate to contact the undersigned.

Respectfully,

LDS CONSULTANTS

Rebecca Walker, P.Eng.
Principal, Geotechnical Services
Office: 226-289-2952
Cell: 519-200-3742
rebecca.walker@LDSconsultants.ca

LDS

Proposed Aggregate Pit
Hunt Road and Gore Road
GE-00260

Well Survey Questionnaire

Contact Name: JAY THORNTON
Address: 642699 ROAD 64, RR#3
INGERSOLL ON
N5C 3J6
Contact (email or phone): Jays_yj@hotmail.com

Please be advised that any information that is provided to LDS for the above address may be circulated to various approval authorities, including but not limited to City of London and Upper Thames River Conservation Authority, and may be available to the public through a Freedom of Information request.

☑ ***I agree to provide the following information*** *(please sign and date the bottom of the form):*

Confirmation of Existing Water Supply Well

☐ No – There are no water supply wells present at the address noted above

☑ Yes – There is one (or more) water supply wells at the address noted above. Additional details outlined below.

Location of Well *(Provide description - If preferred, you can provide a sketch on the back of this page)*	IN FRONT OF HOUSE WEST SIDE 300' FROM ROAD
Depth of Well (estimate, if not known) 180'	**Date Drilled** (estimate, if not known) LATE 80'S EARLY 90'S
Water Usage: (i.e.: (Domestic Water Supply) / Landscaping / Irrigation)	**Is the property serviced with municipal/city water?** Please circle: **YES** (NO)
Type of Well: (Dug / Bored or Drilled) DRILLED	**Static Water Level:** (estimate, if not known) 15'-20'
Do you use water treatment units? If yes, please specify type of treatment (i.e.: water softener, UV) NO	
Have you experienced water quality issues, or water quantity issues? If yes, please provide a brief description (i.e.: seasonal periods when well goes dry) NO	
Have you experienced any issues with shallow groundwater? If yes, please provide a brief description (i.e.: frequent sump pump running, wet basement) NO	

☐ ***I prefer not to participate and decline to provide information for the above noted address.***

Signature _____ **Date** AUG 12/19

LDS

Proposed Aggregate Pit
Hunt Road and Gore Road
GE-00260

Well Survey Questionnaire

Contact Name: Brentridge Holsteins Ltd.
Address: 1160 Hunt Rd
Ingersoll ON N5C 3J6
Contact (email or phone): 519-649-8847 Claire + Brent Pike

Please be advised that any information that is provided to LDS for the above address may be circulated to various approval authorities, including but not limited to City of London and Upper Thames River Conservation Authority, and may be available to the public through a Freedom of Information request.

[X] ***I agree to provide the following information*** *(please sign and date the bottom of the form):*

Confirmation of Existing Water Supply Well

☐ No – There are no water supply wells present at the address noted above

☒ Yes – There is one (or more) water supply wells at the address noted above. Additional details outlined below.

Location of Well
(Provide description - If preferred, you can provide a sketch on the back of this page)

Depth of Well (estimate, if not known) 65 ft	**Date Drilled** (estimate, if not known) ?
Water Usage: Domestic + Dairy farm (i.e.: Domestic Water Supply / Landscaping / Irrigation)	**Is the property serviced with municipal/city water?** Please circle: YES (NO)
Type of Well: (Dug / Bored or Drilled) Drilled	**Static Water Level:** (estimate, if not known) ?

Do you use water treatment units? Yes, Iron filter
If yes, please specify type of treatment (i.e.: water softener, UV)

Have you experienced water quality issues, or water quantity issues? NO.
If yes, please provide a brief description (i.e.: seasonal periods when well goes dry)

Have you experienced any issues with shallow groundwater? NO.
If yes, please provide a brief description (i.e.: frequent sump pump running, wet basement)

☐ ***I prefer not to participate and decline to provide information for the above noted address.***

C. Pike
Signature

Apr 20/20
Date

Newbarn/House well 1 of 2.

LDS

Proposed Aggregate Pit
Hunt Road and Gore Road
GE-00260

Well Survey Questionnaire

Contact Name: Brentridge Holsteins Ltd.
Address: 1160 Hunt Rd
Ingersoll ON N5C 3J6
Contact (email or phone): 519-649-8847 Claire + Brent Pike

Please be advised that any information that is provided to LDS for the above address may be circulated to various approval authorities, including but not limited to City of London and Upper Thames River Conservation Authority, and may be available to the public through a Freedom of Information request.

[X] ***I agree to provide the following information*** *(please sign and date the bottom of the form):*

Confirmation of Existing Water Supply Well

☐ No – There are no water supply wells present at the address noted above

☒ Yes – There is one (or more) water supply wells at the address noted above. Additional details outlined below.

Location of Well
(Provide description - If preferred, you can provide a sketch on the back of this page)

Depth of Well (estimate, if not known) 250ft	**Date Drilled** (estimate, if not known) ?
Water Usage: Hc Cattle (i.e.: Domestic Water Supply / Landscaping / Irrigation)	**Is the property serviced with municipal/city water?** Please circle: YES (NO)
Type of Well: (Dug / Bored or Drilled) Drilled	**Static Water Level:** (estimate, if not known) ?

Do you use water treatment units? NO.
If yes, please specify type of treatment (i.e.: water softener, UV)

Have you experienced water quality issues, or water quantity issues?
If yes, please provide a brief description (i.e.: seasonal periods when well goes dry) NO, lots of sulfur

Have you experienced any issues with shallow groundwater?
If yes, please provide a brief description (i.e.: frequent sump pump running, wet basement) NO.

☐ ***I prefer not to participate and decline to provide information for the above noted address.***

C Pike
Signature

Apr 20/20.
Date

old barn well 2 of 2

Proposed Aggregate Pit
Hunt Road and Gore Road
GE-00260

Well Survey Questionnaire

Contact Name: Mike Albright

Address: 839 Hunt Road Dorchester Ont

Contact (email or phone): malbright839@gmail.com 519 902 0797

Please be advised that any information that is provided to LDS for the above address may be circulated to various approval authorities, including but not limited to City of London and Upper Thames River Conservation Authority, and may be available to the public through a Freedom of Information request.

☑ ***I agree to provide the following information*** *(please sign and date the bottom of the form):*

Confirmation of Existing Water Supply Well

☐ No – There are no water supply wells present at the address noted above

☑ Yes – There is one (or more) water supply wells at the address noted above. Additional details outlined below.

Location of Well
(Provide description - If preferred, you can provide a sketch on the back of this page)
See attached for rough dwg

Depth of Well (estimate, if not known)	**Date Drilled** (estimate, if not known) ?
Water Usage: Domestic (i.e.: Domestic Water Supply / Landscaping / Irrigation)	**Is the property serviced with municipal/city water?** Please circle: YES (NO)
Type of Well: (Dug / Bored or Drilled) ?	**Static Water Level:** (estimate, if not known) 16' from ground level

Do you use water treatment units?
If yes, please specify type of treatment (i.e.: water softener, UV) Softener UV Trojan.

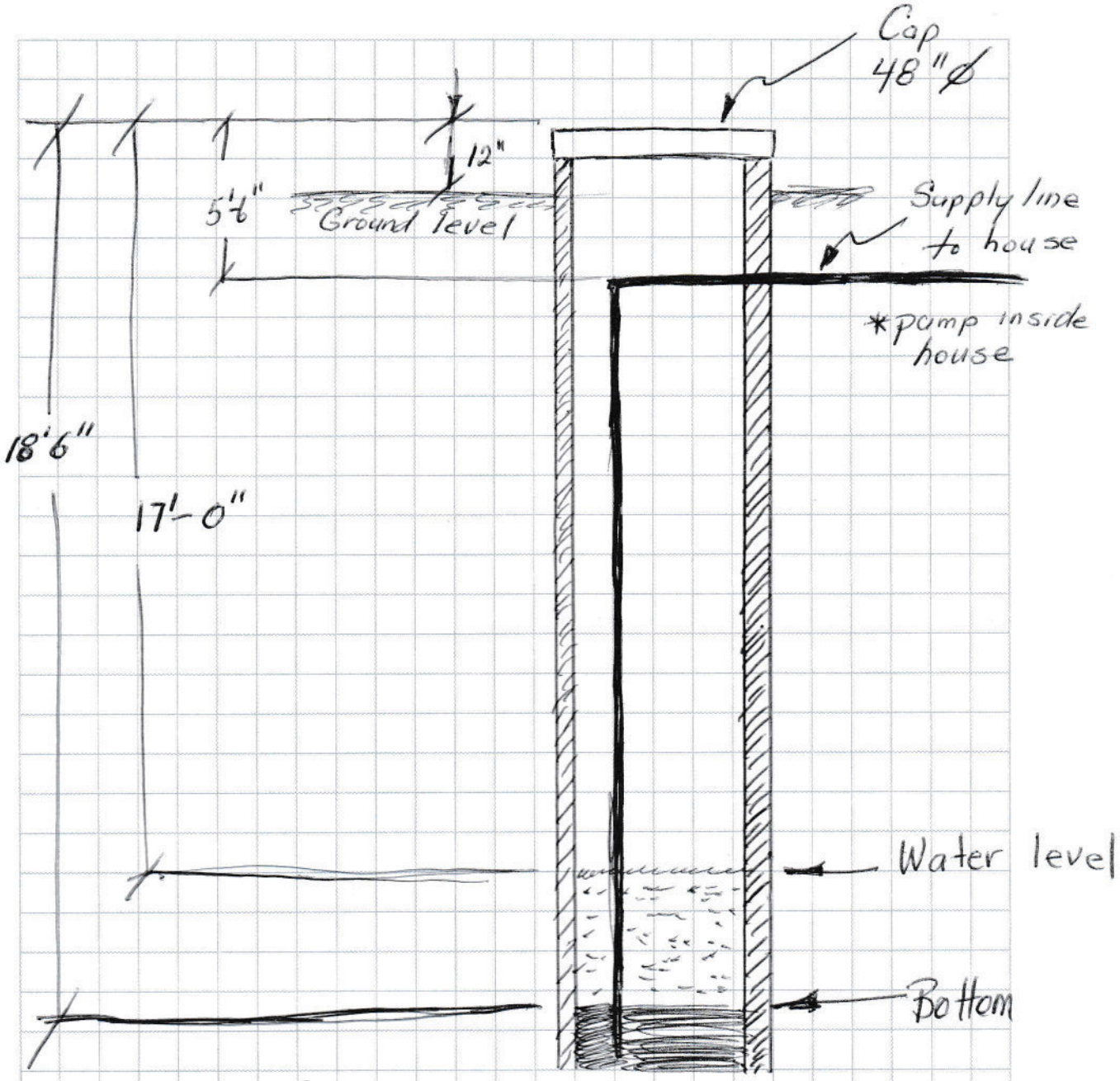
Have you experienced water quality issues, or water quantity issues?
If yes, please provide a brief description (i.e.: seasonal periods when well goes dry)
No

Have you experienced any issues with shallow groundwater?
If yes, please provide a brief description (i.e.: frequent sump pump running, wet basement)
No

☐ ***I prefer not to participate and decline to provide information for the above noted address.***

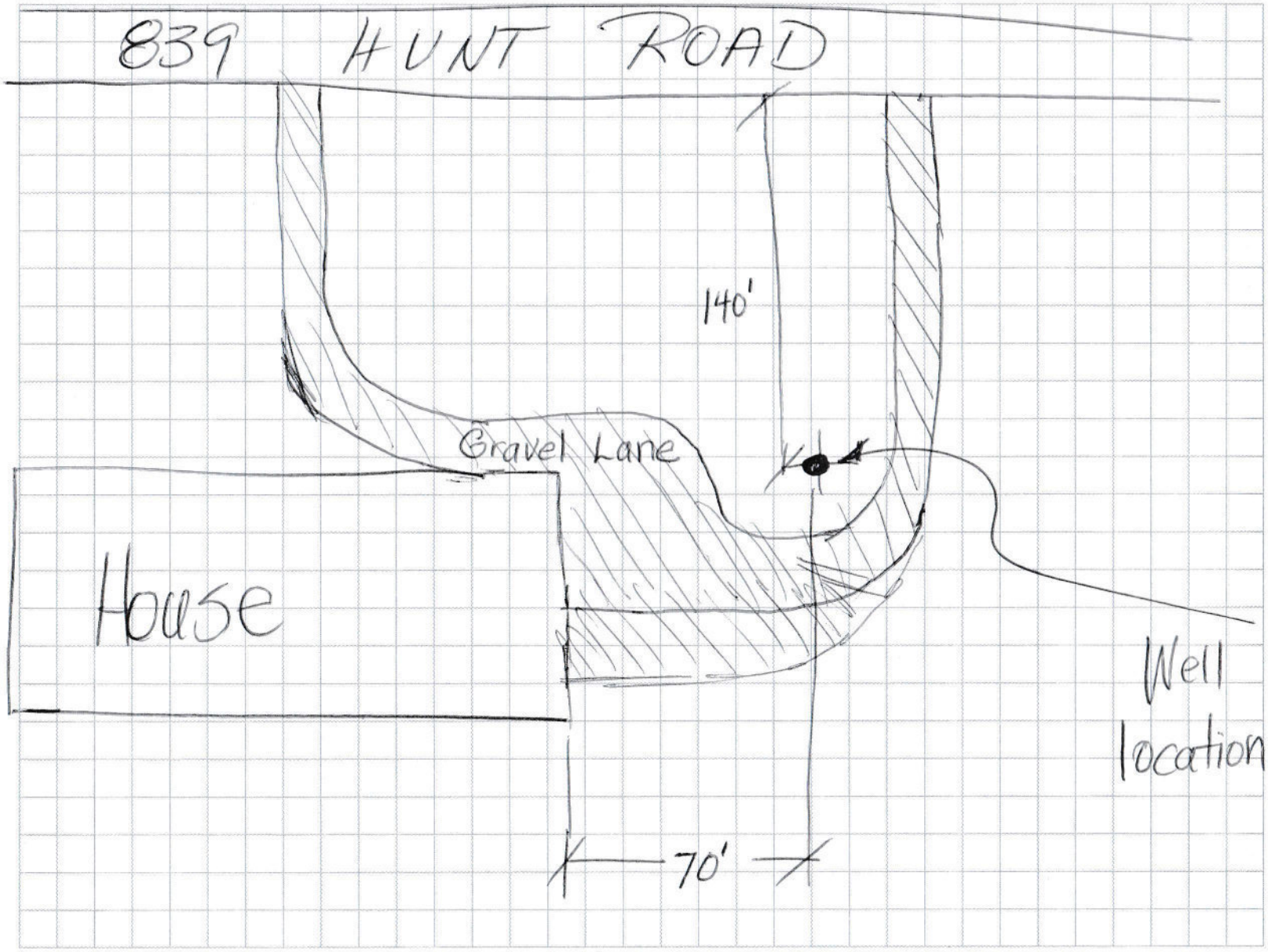
Mike Albright
Signature

Sept 2, 2019
Date



839 Hunt Road
Dorchester Ont
Mike Albright

Sept 2019


839 HUNT ROAD
140'
Gravel Lane
House
Well location
70'

APPENDIX G

WATER BALANCE CALCULATIONS

WATER BALANCE CALCULATION WORKSHEET

Pre Development Condition

Site Parameters		Month	Temperature °C	Precipitation (mm)	Actual Evapotranspiration (mm)	Adjusted ET (mm)	Soil Storage (mm)	Surplus Water (mm)	Potential Infiltration (mm)	Actual infiltration depth (mm)	Actual infiltration Volume (m^3)	Potential Runoff (mm)	Actual Runoff depth (mm)	Actual Runoff Volume (m^3)	
Area (ha):	21.0	January	-6.4	72.48	8.85	8.85	149.27	63.63	31.82	0.00	0.00	31.82	0.00	0.00	
Impervious	0%	February	-5.5	59.84	10.44	10.44	149.50	49.39	24.70	0.00	0.00	24.70	0.00	0.00	
Soil Type	A	March	-0.4	76.67	20.14	20.14	150.00	56.52	28.26	0.00	0.00	28.26	0.00	0.00	
Soil Moisture Capacity (mm)	150	April	6.4	81.57	37.43	37.43	150.00	44.14	22.07	114.87	24123.42	22.07	83.94	17627.20	
INFILTRATION FACTOR		May	13.1	82.73	69.78	69.78	145.56	12.95	6.48	37.41	7855.97	6.48	88.81	18650.63	
Topography factor	0.1	June	18.0	85.72	98.57	98.57	126.49	-12.85	-6.43	0.00	0.00	-6.43	0.00	0.00	
Soils Factor	0.3	July	20.5	80.91	107.61	107.61	93.81	-26.70	-13.35	0.00	0.00	-13.35	0.00	0.00	
Cover Factor	0.1	August	19.6	82.25	84.38	84.38	87.29	-2.13	-1.06	0.00	0.00	-1.06	0.00	0.00	
Total INFIL Factor	0.5	September	15.3	97.33	52.52	52.52	106.36	44.82	22.41	22.41	4705.64	22.41	22.41	4705.64	
		October	9.1	81.48	30.74	30.74	130.86	50.73	25.37	25.37	5326.78	25.37	25.37	5326.78	
		November	3.3	95.32	16.23	16.23	145.71	79.08	39.54	39.54	8303.86	39.54	39.54	8303.86	Check
		December	-3.0	88.03	10.10	10.10	148.90	77.93	38.96	0.00	0.00	38.96	0.00	0.00	P=ET+I+R
		Total:		984.31	546.7875	546.79			218.76	239.60	50,315.67	218.76	260.07	54,614.11	984.31

Post Development Condition

Site Parameters		Month	Temperature °C	Precipitation (mm)	Actual Evapotranspiration (mm)	Adjusted ET (mm)	Soil Storage (mm)	Surplus Water (mm)	Potential Infiltration (mm)	Actual infiltration depth (mm)	Actual infiltration Volume (m^3)	Potential Runoff (mm)	Actual Runoff depth (mm)	Actual Runoff Volume (m^3)	
Area (ha):	21.0	January	-6.4	72.48	8.85	23.16	149.27	63.63	39.77	0.00	0.00	9.55	0.00	0.00	
Impervious	0%	February	-5.5	59.84	10.44	21.56	149.50	49.39	30.87	0.00	0.00	7.41	0.00	0.00	
Soil Type	C	March	-0.4	76.67	20.14	32.86	150.00	56.52	35.33	0.00	0.00	8.48	0.00	0.00	
Soil Moisture Capacity (mm)	150	April	6.4	81.57	37.43	47.36	150.00	44.14	27.59	143.59	30154.28	6.62	25.18	5288.16	
Total Pond Area (ha):	*11.33*	May	13.1	82.73	69.78	72.69	145.56	12.95	8.09	46.76	9819.96	1.94	20.50	4305.66	
Total Reforestation (ha):	*0.76*	June	18.0	85.72	98.57	95.68	126.49	-12.85	-8.03	0.00	0.00	-1.93	0.00	0.00	
Total Meadow Area (ha):	*3.41*	July	20.5	80.91	107.61	101.60	93.81	-26.70	-16.69	0.00	0.00	-4.01	0.00	0.00	
Total Wetland Area (ha):	*0.8*	August	19.6	82.25	84.38	83.90	87.29	-2.13	-1.33	0.00	0.00	-0.32	0.00	0.00	
INFILTRATION FACTOR		September	15.3	97.33	52.52	62.60	106.36	44.82	28.01	28.01	6066.92	6.72	6.72	1411.69	
Topography factor	0.1	October	9.1	81.48	30.74	42.16	130.86	50.73	31.71	31.71	6867.74	7.61	7.61	1598.03	
Soils Factor	0.2	November	3.3	95.32	16.23	34.03	145.71	79.08	49.43	49.43	10706.05	11.86	11.86	2491.16	Check
Cover Factor	0.1	December	-3.0	88.03	10.10	27.64	148.90	77.93	48.70	0.00	0.00	11.69	0.00	0.00	P=ET+I+R
Total INFIL Factor	0.4	Total:		984.31	546.7875	645.23			273.45	299.50	63,614.94	65.63	71.88	15,094.70	984.31

Summary		Units	Notes
Runoff	- 39,519.41	m^3	Net reduction in run-off from existing to proposed site conditions
Infiltration	13,299.27	m^3	Net increase in infiltration (groundwater recharge)

Total Area to be Licensed 21.0 ha

Restoration Plan

Open water pond	11.33 ha
Wetland	0.80 ha
Reforestation	0.76 ha
Sideslope/meadow	3.41 ha
Total Area	16.30 ha
Note: Reforestation outside extraction area	0.46 ha

General Assumptions

-Infiltration factor is applied to surplus water
-When surplus is negative, moisture is drawn from the soil
-No Infiltration or runoff in winter months (<0°C)
-Winter runoff volumes is runoff in April (50%) and May (50%)
-Winter infiltration volumes infiltrated in April (75%), and May (25%)
-Actual ET is adjusted based on increased evaporation from the pond surface, (pond area noted above)
-25mm event represents 90% of annual runoff.
-Due to the resulting pond planned onsite, 75% of actual post developmet runoff will be evaporated or infiltrated
  -37.5% of Post development runoff will be added to the infiltration total
  -37.5% of Post development runoff will be added to the evapotranspiration total

Infiltration Factors

TOPOGRAPHY	Flat Land, average slope < 0.6 m/km (<0.1%)	0.30
	Rolling Land, average slope 2.8 m to 3.8 m/km (0.3%)	0.20
	Hilly Land, average slope 28 m to 47 m/km (5%)	0.10
SOILS	Fine sand	0.40
	Fine sandy loam	0.30
	Silt loam	0.20
	Clay loam	0.15
	Clay	0.10
COVER	Urban lawns / Shallow rooted crops	0.05
	Moderately rooted crops	0.10
	Pasture and shrubs	0.15
	Mature forest	0.20

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.

LDS CONSULTANTS INC.

15875 Robins Hill Road, Unit 1
London, Ontario N5V 0A5

www.ldsconsultants.ca