CONSOLIDATED GEOTECHNICAL INVESTIGATION & HYDROGEOLOGICAL ASSESSMENT REPORT

FOREST VIEW SUBDIVISION
ROUGHAM ROAD & PARKHOUSE DRIVE
MOUNT BRYDGES, ONTARIO

LDS PROJECT NO. GE-00103

MARCH 25, 2024

Submitted to:

SIFTON PROPERTIES LIMITED

Distribution (via email):

Sifton Properties Limited – Devon Posthumus, Planner

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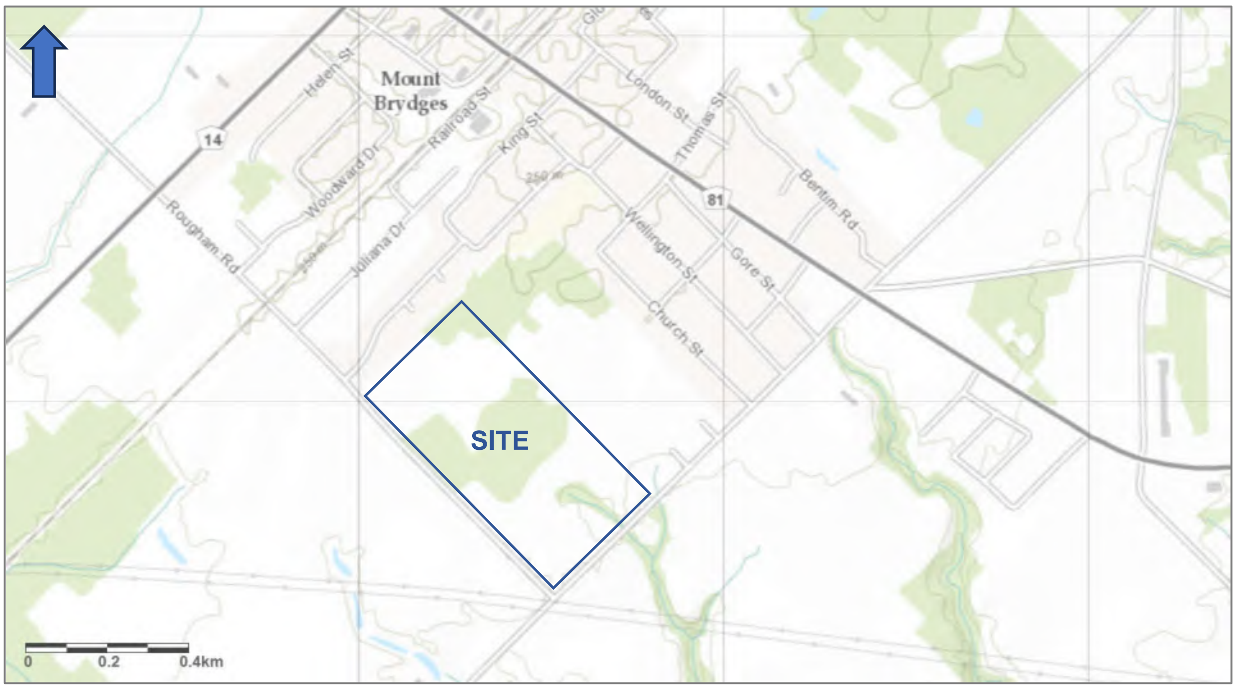
1.0 INTRODUCTION

LDS Consultants Inc. (LDS) has been retained by Sifton Properties Limited. to conduct a Geotechnical Investigation and Preliminary Hydrogeological Assessment for a residential subdivision development. The subject property is located on the north side of Parkhouse Drive, east of Rougham Road, in the village of Mount Brydges. The legal description of the property is South Part Lot 17, Concession 2, in the former geographic Township of Caradoc.

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

Figure 1: Key Plan



A residential subdivision is planned for the site, current draft plan incorporates approximately 96 single family lots and 4 medium density blocks accessed with a local road network. A stormwater management facility is planned for the southeast corner of the site, next to the Edgewood Subdivision SWM Block. A concept plan is provided on Drawing 1, in Appendix A.

The scope of work for the Geotechnical Investigation and Preliminary Hydrogeological Assessment was outlined in LDS' proposal (reference G2016-065, dated October 17, 2017). This work was completed as part of the due diligence required for the land purchase.

Authorization to carry out this work was received from Mr. Phil Masschelein, on behalf of Sifton Properties Limited (Sifton), on October 17, 2017. This report update was requested by Devon Posthumus on behalf of Sifton in March 2024. It is noted that in 2017, two separate reports were issued for the site – one Geotechnical Report and one Hydrogeological Report (prepared in March 2019). This current report update consolidates these two reports into one document, to facilitate review and consultation, and approvals with the Municipality.

1.1 Geotechnical Terms of Reference

This document has been prepared for the purposes of providing geotechnical comments and recommendations for design and construction of the proposed residential development, in Mount Brydges, Ontario. This report provides a summary of the borehole findings (documenting soil and groundwater conditions at the site). This report also includes geotechnical comments and recommendations for the proposed residential development, including: site preparation (including the re-use of excavated materials as engineered fill, trench backfill), excavations and groundwater control, foundation design, slab on grade and basement construction, site servicing, pavement design, curb and sidewalk construction, and recommendations for inspection and testing services during construction.

This report is provided on the basis of the terms noted above, and on the assumption that design will follow applicable codes and standards. Site investigation and recommendations provided in this report follow generally accepted practice for geotechnical consultants in Ontario. The format and content of this report has been guided to address specific client needs. Laboratory testing, where applicable, follows ASTM or CSA Standards.

1.2 Hydrogeological Terms of Reference

This Hydrogeological discussion in this report has been prepared for the purposes of examining the hydrogeological characteristics of the site. The scope of work has included a desktop study including a review of available geological mapping, Ministry of Environment, Conservation and Parks (MECP) well records, and the Elgin-Middlesex Groundwater Study. The field program carried out for the Geotechnical Investigation was considered appropriate for characterizing the soil and shallow groundwater conditions at the site.

This Hydrogeological Assessment has been prepared in general conformance with recommendations outlined in the document titled, *Hydrogeological Assessment Submissions: Conservation Authority Guidelines to Support Development Applications – June 2013*. The report includes the following:

- Site location and description;
- Summarized conditions, including topography, physiography, geology and borehole and monitoring well findings;
- MECP well record review and well survey findings;
- Description of surface water features, drainage and functions;
- Impact assessment for potential impacts to shallow groundwater and surface water,
- Preliminary water balance calculations; and,
- A discussion for design and construction mitigation measures to prevent and / or limit negative impacts to surface water features and shallow groundwater conditions at the site.

Prior to undertaking the fieldwork for the initial Hydrogeological Investigation, a consulting team meeting was held on December 18, 2018 to coordinate efforts between LDS with regards to hydrogeological work, stormwater management design strategies, and with Natural Resource Solutions Inc. (NRSI) with regards to ecological assessment work for the site, and DAR pre-consultation feedback received from North-South. From that discussion, the following items were identified for inclusion in the Hydrogeological Report:

- Water quality data for the shallow groundwater at the site.
- Discussion outlining LID measures and soil / groundwater suitable to accommodate whatever LID measures are being considered.
- Discussion of mitigation measures to ensure that stormwater from the development will not cause further degradation to downstream water quality.

- Construction dewatering / PTTW be requirements, including estimated volumes and associated zone of influence (how to minimize impacts of dewatering on natural features).

This report is provided on the basis of the terms noted above, and on the assumption that the design will follow applicable codes and standards.

1.3 Qualifications of Assessor

This project was conducted under the supervision of Rebecca Walker, P. Eng., QPESA. She 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 (QP) registered with MECP. She has been practicing geoscience services under the Guideline of Professional Engineers Providing Geotechnical Engineering Services under the Professional Engineers Act in Ontario.

Mrs. Walker has over 25 years of direct experience in the geotechnical and hydrogeological consulting industry. Over 5,000 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 Local Planning Appeal Tribunal (formerly Ontario Municipal Board) hearings and Municipal Councils related to groundwater hydrogeology and geotechnical matters for land development and construction. She has been retained for many projects, both directly and indirectly (as a subconsultant) by local municipalities as a hydrogeological and geotechnical consultant.

2.0 SITE LOCATION AND DESCRIPTION

2.1 Site Description

The subject site is located at the south end of the village of Mount Brydges, north of Parkhouse Drive, and east of Rougham Road. The site is bordered to the northwest along Pamela Drive by existing single family residential lands, and to the northeast, south and west by agricultural land. Although municipal water service is available to residential lands north and east of the site, it is understood that a number of shallow wells are present in the area.

From a topographical perspective, the site exhibits a gradual topographical relief of approximately 4 to 5 m from north to south. In 2021, the field areas were not ploughed or planted. Some topsoil stripping, site grading and fill placement has occurred with the subject lands, although such activities to alter the site conditions were halted when the municipality introduced a Site Alteration By-Law which limited any further activities from occurring until Subdivision Agreements were finalized.

The parcel includes two woodlots. The northerly hedgerow feature extends across the north end of the Forest View subdivision. The central woodlot splits the Forest View lands into a north and south development area. The woodlots are identified as Significant Woodlands under Schedule C of the County of Middlesex Official Plan (2006) and Woodlands under Schedule G of the Municipality of Strathroy-Caradoc Official Plan. NRSI indicates that the wooded areas are locally significant, and mainly comprised of deciduous forest and deciduous swamp. Trees within the central woodlot, may provide suitable habitat for species at risk (SAR) bats. The wetland features within the woodlots were evaluated by NRSI under the Ontario Wetland Evaluation System. It is understood that the wetland pockets located within the north and central wooded areas have not been deemed to be ‘provincially significant’. Confirmation was received from MNRF staff, that the wetlands features are not considered to meet the criteria of provincially significant. Within the central woodlot, the wetland complex located within this woodland feature has been identified as being locally significant, as being a Significant Wildlife Habitat for woodland and amphibian breeding. Further, it is noted that the wetland areas have been identified as having anurans (frogs and toads) present, as well as their associated breeding habitat. Monitoring of the continued presence of these species has been incorporated into the monitoring plans through the construction and post-construction period.

Within the south end of the Forest View lands (along the east side of the parcel), there is a short section of valley along the northerly extent of a tributary of the Mill Creek watercourse and municipal drain. The entire length of the valley land is vegetated. Current tilling of the field along the south edge of the feature comes very close to the crest of the valley and offers little riparian habitat A small pond feature (currently approximately 0.5 m depth) is located at the upper most part of the drainage feature, and historical review of aerial photographs indicate that the pond was likely used as an irrigation pond; however, the current vegetation around the pond suggests that it has not been used for this purpose in recent years. Water was not observed to actively discharge from the pond to the tributary, although signs of erosion downstream of the pond indicate intermittent flows may occur. The drain is conveyed through a culvert at Parkhouse Drive, and continues through the lands which are south of Parkhouse Drive.

The small tributary extends into the southeastern limit of the site, providing surface water drainage towards the south. Surface water is directed through an existing culvert at Parkhouse Drive. The southwest tributary connects into a drainage channel to the south which has been identified as part of a Significant Valley System under the Middlesex County Natural Heritage study. Lower Thames Valley Conservation Authority (LTVCA) has jurisdiction over their regulated lands which are present to the southwest of the site.

An aerial photograph is shown on Drawing 2, in Appendix A. The location of the woodlots, valley system and other site features are identified on the drawing.

With the exception of a butternut tree, no species at risk (SAR) were identified in the woodlots and wetland areas. This Butternut tree is within the Forest View lands The Butternut tree was assessed by an NRSI Butternut Health Assessor and determined to be a pure, Category 2 tree. A BHA report was provided to MECP.

The presence of potential SAR breeding and roosting habitat was identified, in the form of cavity trees within the woodlots. The woodlots are being maintained as open space blocks, within each of the proposed developments. Buffers from the woodlots and wetland features have been established through the work completed by the ecological consultants. In determining the appropriate buffer setback for the residential developments, consideration was given to maintaining the form and function of the features, and maintaining the general characteristics of the respective features, as well as providing connectivity for wildlife in the area.

As noted in the ecological studies prepared by others, the cumulative impact of residential developments largely centers upon the separation of the identified natural features by residential development and roadways. It is unlikely that the development will affect the movement of birds, but the potential for movement of ground mammals (as opposed to bats), reptiles, and amphibians will be impacted. However, no significant species were identified and low numbers of amphibians were observed. The natural heritage features have been separated by actively farmed land for decades and the northern woodland is already surrounded on two sides by an established neighbourhood. As a result, movement between natural features was already limited and wildlife are fairly acclimatized to residential disturbance.

2.2 Site Topography and Surface Drainage

From a topographical perspective, the site exhibits a gradual relief of approximately 4.5 m from north to south.

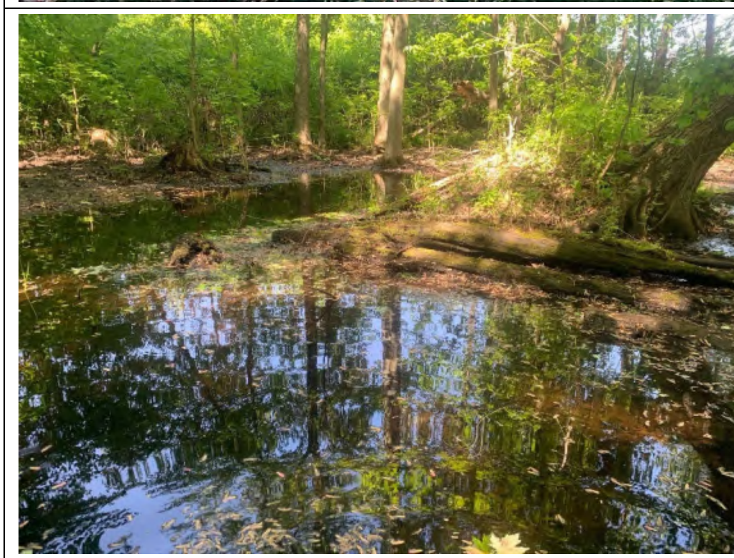
A small tributary extends into the southeastern limit of the site, providing surface water drainage towards the south. Based on a review of historical aerial photographs, this area formerly contained an irrigation pond, which has since been abandoned, and the surrounding area has naturalized around it.

Surface water which is discharged through the tributary is directed through an existing culvert at Parkhouse Drive. The upstream end of the culvert is set at Elevation 240.0 m. The downstream tributary has been identified as part of a Significant Valley System under the Middlesex County Natural Heritage study. Lower Thames Valley Conservation Authority (LTVCA) has jurisdiction over their regulated lands which are present to the south. The location of the woodlots, valley system and other site features are identified on an aerial photograph provided on Drawing 2, in Appendix A.

2.3 Surface Water Features

The surface water features located within the woodland areas within the Forest View Subdivision have been reviewed through the ecological review and preparation of DAR reports, with supplemental documentation of the surface water / wetland features by LDS.

Under seasonal conditions, the volume and extent of surface water within the woodlot areas is variable, with some features maintaining water throughout the year, and some drying out through the warmer summer months. The following photographic log is provided for reference, with site conditions documented on May 26, 2023.

Photographic Record	Description
	Surface Water and Anuran Monitoring Points established in consultation with NRSI.
	ANR2 Existing wetland feature in northeast corner of central woodlot, near the shared Edgewood / Forest View boundary.
	SWS3 Existing wetland feature in northeast corner of central woodlot, near the shared Edgewood / Forest View boundary.

Photographic Record	Description
	ANR4 / SWS4 Existing wetland feature located in west end of central woodlot on Forest View Subdivision lands, near Rougham Road.
	ANR3 / SWS5 Existing pond in south wooded area located within Forest View Subdivision lands.

2.4 Review of Available Mapping

2.4.1 LTVCA Regulated Lands

In May 2006, Ontario Regulation 152/06 came into effect in the LTVCA watershed area, which locally implements Generic Regulation (Development, Interference with Wetlands and Alterations to Shoreline and Watercourses). This regulation is intended to ensure public safety, prevent property damage and social disruption due to natural hazards such as flooding and erosion. Ontario Regulation 152/06 is implemented by the local Conservation Authority, by means of permit issuance for works in or near watercourses, valleys, wetlands, or shorelines, when required. It is noted that effective April 1, 2024, the LTVCA Generic Regulation will be replaced with O.Reg. 41/24, which in part, is expected to streamline the permitting process with the various Conservation Authorities.

The ‘Significant Valley System’ which is located to the southwest corner of the site is part of the LTVCA Regulated lands. Property owners must obtain permission from LTVCA before beginning any development, site alteration, construction, or placement of fill within the regulated area. Proposed development within the study area will be subject to the above referenced Regulation. Consultation with the local Conservation Authority for review of site-specific development plans is recommended in this regard.

2.4.2 Source Water Protection Mapping

LDS has reviewed the Ministry of Environment, Conservation and Parks (MECP) Source Water Protection Information Atlas and Thames-Sydenham and Region mapping to determine whether the site is located in any identified areas of source water concern, as they relate to local groundwater quality (current to January 2024).

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 following observations were recorded by LDS:

- The Property is located within the Lower Thames Valley Source Protection Area.
- The Property is not located in any of the following designated areas listed in the MECP Source Protection mapping:
  - Wellhead Protection Area, Wellhead Protection Area E (GUDI), Wellhead Protection Area Q1 or Wellhead Protection Area Q2;
  - Intake Protection Zone or Intake Protection Zone Q;
  - Issue Contributing Area; or, Event Based Area.
- The Property is located within a Significant Groundwater Recharge Area, with a rating/score of 4, indicative of a medium vulnerability rating.
- The Property is located within a Highly Vulnerable Aquifer with a rating/score of 6, indicative of a high vulnerability rating.

The above comments are demonstrated on Drawing 3, in Appendix A.

Development at the site may result in potential impacts to surface water and groundwater receptors, as well as natural heritage features in the area. Development must have regard for the sensitivity of the shallow aquifer, and the design of the proposed development must incorporate suitable measures and design aspects to minimize negative effects to the shallow groundwater aquifer. This is addressed through strategic stormwater management design, the use of contingency and mitigation measures to limit development impacts.

2.4.3 Geological Mapping

Select geological mapping and publications were reviewed for the purposes of reviewing regional characteristics for soil conditions in the Mount Brydges area. Findings are summarized below, for reference.

Physiography

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 Mount Brydges is located in the Physiographic Region as the Caradoc Sand Plains and London Annex Sand plains. The Caradoc Sand Plain was formed from water-laid alluvial / beach deposits. This area is generally characterized by layered deposits of silt and sand, with occasional sand or sand and gravel ridges / dunes near surface, which are located northeast and southwest of the village of Mount Brydges. The deposit thins to the west, where the sand plain blends into the Ekfrid Clay Plain.

Aggregate Resource

The *Aggregate Resources Inventory of the County of Middlesex and the City of London, Southern Ontario (ARIP 78), 2016* identifies that predominant sand soils in the area are of tertiary significance. Deposits of tertiary significance may have poor quality (high and / or variable fines content), which requires additional screening and handling, resulting in increased production costs; be found below thick overburden cover, and / or encountered below the stabilized groundwater level which increases the amount of work required for extraction; and / or; be in close proximity to natural features (significant wetlands or woodlots) or local permanent infrastructure (such as roads, rail lines, housing) which may result in constraints to the accessibility of material or may prohibit extraction in its entirety.

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 Hamilton Group formation, from the Devonian Period.

Geological publications and well records in the area indicate that the bedrock surface is below 60+ metres of overburden soils in the vicinity of the site. Bedrock was not encountered during the fieldwork for this investigation.

2.4.4 MECP Well Records

Much of the village of Mt Brydges is now fully serviced with municipal water. However, it is noted that the MECP well records for the area identify the presence of shallow (sand point well installations) and deep overburden drilled wells within the general area. Anecdotally, the bedrock is not generally considered a viable source of potable groundwater due to limited yields and aesthetically marginal to poor water quality.

Drawing 4 (in Appendix A) shows the location of wells (with Well Registration No.) which are in close proximity to the site. A summary of the well records is provided in Table 1, (refer to the following page). Water supply wells are typically set into shallow (less than 10 m deep) deposits of sand. Cluster observation wells were also noted near the site, with similar depths. Static water levels in the water supply wells and observation wells are generally measured at depths of 0.9 to 3.7 m depth. Shallow groundwater conditions are consistent with the water levels recorded in the monitoring wells installed at the site.

Monitoring wells which have been installed at the site have been registered with MECP. It is recommended that the wells be maintained for the purposes of collecting seasonal water level measurements, in support of more detailed a Hydrogeological study to support the proposed development.

Table 1: MECP Well Record Summary

Well ID	Well Registration	Depth (m, bgs)	Water Found (m)	Static Water Level (m)	Pump Rate (LPM)	Northing	Easting	Distance from Site (m)
Water Supply								
4100253	12/31/1960	9.75	4.88	4.88	30.28	4749193	459833.4	201.5
4100268	10/5/1963	6.1	3.05	3.05	30.28	4749333	459673.4	213.3
4109027	10/10/1979	6.1	3.66	3.66	11.36	4749203	459813.4	204.8
4109735	7/10/1982	7.92	6.1	6.1	7.57	4749223	459833.4	176.7
4109736	7/10/1982	7.92	6.1	6.1	7.57	4749203	459833.4	193.1
4109737	7/10/1982	7.62	6.1	6.1	7.57	4749223	459813.4	189.5
4111922	11/15/1989	9.75	7.32	3.96	22.71	4749244	459823.4	167.3
4113183	12/15/1994	7.01	2.13	2.13	11.36	4750067	459670.4	13.8
4114944	6/19/2002	9.14	2.44	1.52	22.71	4750114	459525.8	136.7
4116584	6/8/2006	11.43	2.44	2.44	37.85	4750272	459621	220.3
7046018	5/24/2007	3.81	2.13	2.13	37.85	4750191	459731	151.7
7372819	8/17/2020	5.64	2.13	--	--	4750202	459535	194.1
7390737	5/10/2021	4.57	2.59	--	--	4750228	459751	193.7
7420407	5/1/2022	1.68	1.68	--	--	4750195	459695	143.1
7323735	9/27/2018	8.84	--	3.66	37.85	4749178	459820	221.3
Observation / Monitoring Wells								
4116089	5/25/2005	4.37	0.9	--	--	4749406	459985	0.2
7283725	1/26/2017	4.57	--	--	--	4749654	460172	83.9
7338656	1/24/2019	3.05	1.52	1.52	--	4749540	460122	On Site
7338659	1/24/2019	3.05	1.52	1.52	--	4749403	459992	7.2
Other								
7169070 N/R	8/8/2011	79.55	--	3.05	37.85	4750038	459374	186.9
7179358 N/R	3/21/2012	5.49	--	3.66	30.28	4750078	459521	114.0
7301398 N/R	11/3/2017		--	--	--	4749919	459518	1.3
4116315 Abandoned	11/4/2005	60.96	--	--	--	4749438	460048	20.3
4116316 Abandoned	11/1/2005	28.96	--	--	--	4749415	460048	37.0

3.0 INVESTIGATION PROGRAM

LDS carried out a field program of boreholes on October 30 and November 3, 2017. The boreholes were advanced at the site by a local drilling-contractor, using a track-mounted drill-rig. Eight boreholes were advanced at the site, and were excavated to a maximum depth of 6.55 m below existing grade.

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

Table 2: Borehole Locations

ID	Northing	Easting	Ground Surface Elevation, m asl
BH1 (MW)	4749913.9	459518.7	247.96
BH2	4749989.1	459699.9	247.84
BH3 (MW)	4749717.7	459748.2	247.38
BH4 (MW)	4749837.6	459777.1	247.83
BH5 (MW)	4749587.4	459815.9	245.91
BH6	4749669.5	459986.5	244.90
BH7	4749391.8	459941.1	244.00
BH8 (MW)	4749540.0	460075.0	243.44

Monitoring wells were installed in five boreholes (Boreholes 1, 3, 4, 5, and 8) to allow for monitoring the stabilized groundwater level at the site. The Monitoring Wells were constructed of 2-inch (50.8 mm) diameter CPVC screens and riser pipes fitted with an end cap at bottom. 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 wells have been equipped with lockable caps. Details of the monitoring well construction are summarized below:

Table 3: Monitoring Well Construction

Borehole	Ground Surface Elevation, m asl	Completion Depth, m bgs	Screened Length, m	Screened Strata
BH1 (MW)	247.96	6.10	3.05	Compact fine sand
BH3 (MW)	247.38	6.10	3.05	Compact silt, trace sand
BH4 (MW)	247.83	6.10	3.05	Loose Sandy Silt
BH5 (MW)	245.91	6.10	3.05	Compact Sandy Silt
BH8 (MW)	243.44	6.10	3.05	Compact fine sand and sandy silt

The monitoring wells have been registered with MECP, in accordance with Ontario Regulation (O.Reg.) 903.The depth to groundwater seepage and short-term water level measurements were obtained prior to backfilling the remaining boreholes. Boreholes were backfilled with a mixture of bentonite chips and cuttings, to restore holes back to level conditions with the ground surface.

The fieldwork was supervised by a member of LDS' technical staff. All samples recovered from the site were returned to LDS for detailed examination and selective testing. Laboratory testing for this investigation included three gradation analyses which were carried out on select samples of the sandy subgrade soils collected from the site. Collected samples will be disposed of following issuance of the Geotechnical Report, unless prior arrangements have been made for longer storage.

Analytical laboratory testing was carried out on groundwater samples, collected from boreholes BH3 and BH8 on December 17, 2018. Groundwater samples for metals analyses were field-filtered prior to preservation using dedicated 0.45 micron in-line filters. As appropriate, laboratory sample bottles were pre-filled by Maxxam Analytics (Maxxam) with preservatives intended to preserve the collected groundwater samples prior to analysis. Following sample collection, the sample bottles were placed into dedicated coolers with ice for storage pending transport to the laboratory.

The water samples were submitted to Maxxam under a Chain of Custody. The analytical testing included the following sampling parameters.

- Bacteriological Parameters: E. Coli, Total Coliforms;
- Nutrients: Nitrate, Nitrite, total Kjeldahl Nitrogen, total Nitrogen, ammonia;
- Dissolved Metals: Standard Metals Package for General Chemistry;
- Cations: Calcium, Magnesium, Sodium, Potassium;
- Anions: Alkalinity, Fluoride, Hydroxide, Carbonate, Bicarbonate, Chloride, Sulphate; and,
- General Inorganic Parameters: pH, Total Suspended Solids, Electrical Conductivity, Hardness.

The results of the analyses are provided in Appendix C, for reference.

4.0 SUMMARIZED CONDITIONS

4.1 Borehole Program

A series of eight boreholes were advanced at the site to examine the soil and shallow groundwater conditions. Approximate locations of the boreholes are shown on Drawing 3, appended.

In general, the soils observed in the boreholes consisted of topsoil directly overlying natural sandy silt and sand soils. General descriptions of the 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 - A 0.1 to 0.2 m thick layer of topsoil was observed at ground surface in all of the boreholes. Topsoil was comprised of sandy loam. It should be noted that topsoil quantities should not be established from information provided at the borehole locations only. If required, a more detailed analysis (involving additional shallow test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

Sand - The predominant soils at the site are comprised of natural fine-grained sand which underlies the topsoil. The sand was generally observed to be in a loose to compact state, based on Standard Penetration Test (SPT) N-values in the range of 2 to 18 blows per 0.30 m penetration of the split-spoon sampler. Moisture contents in select sand samples were measured at 4.0 to 31.2 percent, consistent with the saturated conditions observed below the stabilized groundwater level. Boreholes BH1 and BH2 were terminated within this layer.

Sandy Silt - Within Boreholes BH3 to BH8, a layer of sandy silt was encountered underlying the sand at depths ranging from 2.3 to 4.0 m and extended throughout depth. The silt was generally described as brown to grey with depth, containing trace gravel. Based on SPT N-values in the range of 2 to 21 blows per 0.30 m penetration of the split-spoon sampler. Moisture contents in select samples were measured at 21 to 31 percent, consistent with the saturated conditions observed below the stabilized groundwater table.

4.2 Geotechnical Laboratory Test Results

Grain size analyses testing was carried out on select samples collected from the boreholes. The following table presents the gradation results for the sand and gravel samples which were obtained at the site. The results for the samples are presented below:

Table 4: Sand and Gravel Gradation Results

Parameter	Fine Sand, some Silt		Sandy silt				Silt, trace Sand	
	BH1, SA6	**BH7, SA4**	**BH2, SA4**	**BH4, SA5**	**BH5, SA4**	**BH8, SA1**	**BH3, SA4**	**BH5, SA6**
% Gravel	0	0	0	0	0	0	0	0
% Sand	87.6	69.1	16.0	21.4	16.8	25.5	2.8	7.0
% Silt	12.4	30.9	81.9	77.5	80.7	69.5	95.0	89.1
% Clay	0	0	2.1	1.1	2.5	5.0	2.2	3.9

4.3 Shallow Groundwater Conditions

Short term water level observations were recorded from the open boreholes at the completion of drilling. Short term water levels are summarized in the following table.

Table 5: Short Term Groundwater Observations

Borehole	Ground Surface Elevation, m asl	Groundwater Observations, m bgs	Groundwater Elevation, m asl
BH 1 (MW)	247.96	2.8	240.40
BH 2	247.84	2.8	242.93
BH 3 (MW)	247.38	3.4	242.79
BH 4 (MW)	247.83	3.2	244.61
BH 5 (MW)	245.91	2.8	244.96
BH 6	244.90	4.3	245.99
BH 7	244.00	5.5	245.91
BH 8 (MW)	243.44	5.5	246.39

Additionally, stabilized groundwater levels were measured in the monitoring wells installed at the site between November 2017 and November 2023, and are summarized in Table 6 (on the next page).

Shallow groundwater observed in the boreholes is representative of an unconfined shallow groundwater aquifer. The shallow groundwater flow follows the surface topography, both of which generally slope down towards the southeast. The groundwater flow direction is demonstrated on Drawing 4, in Appendix A.

Shallow groundwater will vary in response to climatic or seasonal conditions, and, as such, may differ at the time of construction, with higher levels possible in wet seasons.

Table 6: Stabilized Groundwater Measurements

Location	Ground Surface Elev. (m)	Depth to Groundwater (m, bgs) / *Groundwater Elevation (m, asl)*													
		07-Nov-2017	14-Nov-2017	27-Nov-2017	17-Jan-2018	05-Feb-2018	27-Feb-2018	22-Mar-2018	18-Apr-2018	14-May-2018	05-Jun-2018	03-Aug-2018	30-Aug-2018	31-Oct-2018	13-Dec-2018
BH1	247.96	2.79 *245.17*	2.72 *245.24*	2.73 *245.23*	2.15 *245.81*	1.98 *245.98*	1.70 *246.26*	1.84 *246.12*	1.62 *246.34*	1.97 *245.99*	2.14 *245.82*	2.53 *245.43*	2.32 *245.64*	2.26 *245.70*	2.07 *245.89*
BH3	247.38	2.74 *244.64*	2.63 *244.75*	2.64 *244.74*	2.31 *245.07*	1.54 *245.84*	1.22 *246.16*	1.29 *246.09*	0.92 *246.46*	*Damaged& repaired*	1.47 *245.91*	1.78 *245.60*	2.08 *245.30*	2.07 *245.31*	1.52 *245.86*
BH4	247.83	2.69 *245.14*	2.27 *245.56*	2.27 *245.56*	1.63 *246.20*	1.42 *246.41*	0.87 *246.96*	1.12 *246.71*	0.71 *247.12*	1.00 *246.83*	1.38 *246.45*	1.56 *246.27*	1.78 *246.05*	1.74 *246.09*	0.71 *247.12*
BH5	245.91	2.16 *243.75*	2.00 *243.91*	2.00 *243.91*	0.83 *245.08*	0.63 *245.28*	0.41 *245.50*	0.59 *245.32*	0.29 *245.62*	0.60 *245.31*	1.07 *244.84*	1.42 *244.49*	1.57 *244.34*	1.20 *244.71*	1.37 *244.54*
BH8	243.44	2.57 *240.87*	2.50 *240.94*	2.51 *240.93*	2.15 *241.29*	1.97 *241.47*	1.63 *241.81*	1.90 *241.54*	1.65 *241.79*	2.02 *241.42*	2.18 *241.26*	2.57 *240.87*	2.48 *240.96*	2.29 *241.15*	2.15 *241.29*

Location	Ground Surface Elev. (m)	Depth to Groundwater (m, bgs) / *Groundwater Elevation (m, asl)*												
		17-Jan-2019	28-Feb-2019	20-Mar-2019	09-Apr-2019	06-May-2019	03-Jun-2019	04-Jul-2019	07-Aug-2019	06-Sep-2019	06-Sep-2019	11-Oct-2019	06-Nov-2019	05-Dec-2019
BH1	247.96	2.00 *245.96*	1.91 *246.05*	1.87 *246.09*	1.82 *246.14*	1.75 *246.21*	1.91 *246.05*	2.10 *245.86*	2.42 *245.54*	2.37 *245.59*	2.37 *245.59*	2.47 *245.49*	2.07 *245.89*	2.10 *245.86*
BH3	247.38	1.43 *245.95*	1.37 *246.01*	1.29 *246.09*	1.30 *246.08*	1.10 *246.28*	1.35 *246.03*	1.52 *245.86*	1.96 *245.42*	2.14 *245.24*	2.14 *245.24*	2.30 *245.08*	1.70 *245.68*	1.52 *245.86*
BH4	247.83	1.25 *246.58*	1.28 *246.55*	1.19 *246.64*	1.07 *246.76*	1.09 *246.74*	1.00 *246.83*	1.34 *246.49*	1.73 *246.10*	1.78 *246.05*	1.78 *246.05*	1.95 *245.88*	1.59 *246.24*	1.46 *246.37*
BH5	245.91	0.65 *245.26*	0.60 *245.31*	0.52 *245.39*	0.53 *245.38*	0.44 *245.47*	0.62 *245.29*	1.23 *244.68*	1.67 *244.24*	1.55 *244.36*	1.55 *244.36*	1.70 *244.21*	0.84 *245.07*	0.76 *245.15*
BH8	243.44	2.10 *241.34*	2.04 *241.40*	1.95 *241.49*	1.93 *241.51*	1.77 *241.67*	1.95 *241.49*	2.22 *241.22*	2.45 *240.99*	2.43 *241.01*	2.43 *241.01*	2.46 *240.98*	2.12 *241.32*	2.06 *241.38*

Location	Ground Surface Elev. (m)	Depth to Groundwater (m, bgs) / *Groundwater Elevation (m, asl)*												
		07-May-2020	05-Jun-2020	02-Jul-2020	10-Aug-2020	09-Sep-2020	21-Oct-2020	12-Nov-2020	15-Dec-2020	13-Jan-2021	04-Feb-2021	04-Mar-2021	09-Apr-2021	03-May-2021
BH3	247.38	1.41 *245.97*	1.48 *245.90*	1.77 *245.61*	1.66 *245.72*	2.00 *245.38*	2.30 *245.08*	2.06 *245.32*	1.69 *245.69*	1.48 *245.90*	1.53 *245.85*	1.51 *245.87*	1.41 *245.97*	1.50 *245.88*
BH4	247.83	1.27 *246.56*	1.34 *246.49*	1.63 *246.20*	1.42 *246.41*	1.73 *246.10*								
BH5	245.91	0.70 *245.21*	1.04 *244.87*	1.47 *244.44*	1.21 *244.70*	1.51 *244.40*	1.72 *244.19*	1.40 *244.51*	0.86 *245.05*	0.74 *245.17*	0.89 *245.02*	0.57 *245.34*	0.64 *245.27*	0.78 *245.13*
BH8	243.44	2.03 *241.41*	2.11 *241.33*	N/R	2.22 *241.22*	2.34 *241.10*	2.4 *241.04*	2.24 *241.20*	2.14 *241.30*	2.00 *241.44*	2.12 *241.32*	2.05 *241.39*	1.98 *241.46*	2.07 *241.37*

Location	Ground Surface Elev. (m)	Depth to Groundwater (m, bgs) / *Groundwater Elevation (m, asl)*										
		04-Jun-2021	12-Apr-2022	09-May-2022	14-Jun-2022	26-May-2023	26-Jun-2023	14-Jul-2023	10-Aug-2023	14-Sep-2023	17-Oct-2023	06-Nov-2023
BH3	247.38	1.65 *245.73*	1.10 *246.28*	246.46 *246.38*	244.64 *246.10*	1.82 *246.01*	1.70 *245.68*	1.23 *246.15*	1.74 *245.64*	2.03 *245.35*	2.28 *245.10*	2.20 *245.18*
BH5	245.91	1.20 244.71	N/R -	N/R -	N/R -	0.00 *245.91*	0.00 *245.91*	-0.10 *246.01*	0.00 *245.91*	1.32 *244.59*	1.77 *244.14*	1.36 *244.55*
BH8	243.44	2.24 *241.20*	1.93 *241.51*	241.81 *241.54*	240.86 *241.24*	0.95 *241.32*	2.24 *241.20*	2.27 *241.17*	2.33 *241.11*	2.45 *240.99*	2.41 *241.03*	2.33 *241.11*

NOTES

(shaded)	Denotes no measurement taken – well no longer available
N/R	No measurement recorded
m, bgs	Metres below ground surface
m, asl	Metres above sea level

4.3.1 Seasonal Variations in Groundwater Levels

Shallow groundwater conditions are present within an unconfined aquifer, with the stabilized groundwater level in the typical range of 1.5 to 3.0 m depth below existing grade, which varies in response to climatic or seasonal conditions, with higher levels occurring in wet periods/seasons. The unconfined aquifer within the subject property is influenced by the site topography and seasonal precipitation conditions. Groundwater fluctuations and influence from significant precipitation rates have been verified on the shallow groundwater level through continuous water level measurements taken with manual readings and continuous groundwater monitoring (collected from dataloggers installed at the site). Seasonal variations recorded at the site are summarized in the following table.

Table 7: Minimum & Maximum Water Level Measurements (LDS, 2018 – 2021)

Location	Spring (Mar – May)	Summer (Jun - Aug)	Fall (Sep – Nov)	Winter (Dec – Feb)
BH1/MW – GS 247.96	245.99 – 246.34	245.43 – 246.05	245.17 – 245.89	245.81 – 246.05
BH3/MW – GS 247.38	245.87 – 246.46	245.42 – 246.03	244.64 – 245.68	245.07 – 246.01
BH4/MW – GS 247.83	246.56 – 247.12	246.10 – 246.83	245.14 – 246.24	246.20 – 247.12
BH5/MW – GS 245.91	245.13 – 245.62	244.27 – 245.29	243.75 – 245.07	244.54 – 245.31
BH8/MW – GS 243.44	241.37 – 241.79	240.87 – 241.49	240.87 – 241.32	241.29 – 241.47

4.3.2 Flow Direction and Gradient

Within the proposed development area south of the central woodlot, the shallow groundwater flow direction is towards the south end of the site. This follows the surface topography which also falls to the south. In the development area on the north side of the central woodlot, the shallow groundwater flow direction is in a west southwesterly direction, towards the central woodlot and Rougham Road. Groundwater Contour Plans under Spring 2018 conditions are provided on Drawing 6, in Appendix A. Subsequent spring time readings through to 2021 confirm a similar trend in the groundwater flow direction throughout the site.

Groundwater gradients under spring and summer conditions are summarized in the following table.

Table 8: Groundwater Gradients

Site Area	Seasonal Condition	Gradient, m/m		
		Maximum	Minimum	Average
North Development Area	Spring Conditions – April 18 2018	0.0082	0.0033	0.0048
	Summer Conditions – August 30, 2018	0.0056	0.0041	0.0047
South Development Area	Spring Conditions – April 18, 2018	0.0253	0.0114	0.0166
	Summer Conditions – August 30, 2018	0.0197	0.0098	0.0149

4.3.3 Groundwater Water Quality

The monitoring wells and piezometers were developed on December 17, 2018. A minimum of three standing water column volumes was drawn from the test locations using a pump equipped with dedicated waterra tubing. LDS staff returned to the site later in the day to collect groundwater samples from the following locations:

- Sample 1: Groundwater Sample, BH3
- Sample 2: Groundwater Sample, BH8

Groundwater samples for metals analyses were field-filtered prior to preservation using dedicated 0.45 micron in-line filters. As appropriate, laboratory sample bottles were pre-filled by Maxxam Analytics (Maxxam) with preservatives intended to preserve the collected groundwater samples prior to analysis. Following sample collection, the sample bottles were placed into dedicated coolers with ice for storage pending transport to the laboratory. The water samples were submitted to Maxxam under a Chain of Custody. The analytical testing included the following sampling parameters.

- Bacteriological Parameters: E. Coli, Total Coliforms;
- Nutrients: Nitrate, Nitrite, total Kjeldahl Nitrogen, total Nitrogen, ammonia;
- Dissolved Metals: Standard Metals Package for General Chemistry;
- Cations: Calcium, Magnesium, Sodium, Potassium;
- Anions: Alkalinity, Fluoride, Hydroxide, Carbonate, Bicarbonate, Chloride, Sulphate; and,
- General Inorganic Parameters: pH, Total Suspended Solids, Electrical Conductivity, Hardness.

The Certificate of Analyses and analytical test results are provided in Appendix C, for reference.

The following observations are considered noteworthy from a review of the general chemistry results:

- Dissolved chloride levels were recorded in the range of 9.7 to 12 mg/L. Corresponding concentrations in the range of 1700 to 2500 µg/L for dissolved sodium, and 380 to 680 µg/L for dissolved potassium were also recorded in the samples. Chloride is widely distributed in nature, generally as the sodium (NaCl) and potassium (KCl) salts. Sodium chloride and, to a lesser extent, calcium chloride ($CaCl_2$) are used for snow and ice control in Canada. Based on the adjacent roads and the historical agricultural use of the property, this result is unsurprising.
- The testing does indicate concentrations of calcium (77,000 and 89,000 µg/L in BH3 and BH8, respectively), and magnesium (19,000 and 18,000 µg/L in BH3 and BH8, respectively), which both contribute to water hardness. There are no numerical Ontario Drinking Water Quality guidelines for calcium or magnesium. The water samples which are considered 'very hard', with hardness levels in the range of 270 to 300 mg/L.

- Background nitrate levels were variable across the two samples, with the concentration in BH3 recorded as <1 mg/L, and the concentration in BH8 measured at 18.4 mg/L. The Ontario Drinking Water Quality Standard guidelines specify the maximum acceptable concentration of nitrates as 10 mg/L.

4.3.4 Groundwater and Surface Water Interactions

Groundwater conditions encountered at the site is generally contained within a shallow unconfined groundwater aquifer. Similar to most shallow aquifer systems, groundwater and surface water at the site have been found to have a close interaction, with consideration of the local topography and the shallow groundwater observed within the boreholes, and the surface water documented in the wetland area. Surface water run-off follows existing ground surface through swales and through infiltration into shallow sandy and weathered subgrade soils

Based on Source Water Protection Mapping, the properties are in an area identified as a high vulnerability aquifer (HVA) as well as a significant groundwater recharge area (SGRA), both with high ratings indicating a high susceptibility to influences which can affect groundwater quality.

Groundwater contributions to the wetland pockets within the central woodland parcels arrives from the site from the permeable surficial soils which are upgradient of the wetland area. It was observed at the piezometer locations along the edge of the wetland area, that during the dry summer months, the groundwater table generally lies below the wetland substrate, except in those instances where localized recharge from high volume rainfall events causes groundwater elevations to rise close to, or above, the ground surface.

Due to the surface water flows that occur under current conditions, and the base flow contributions from upgradient areas around the wetland features, it is anticipated that both surface water and groundwater contributions help to sustain the form and function, and recharges the wetland features.

4.4 Hydraulic Conductivity & Soil Infiltration Rates

4.4.1 Review of Published Data

The Groundwater Information Network (online at www.gin.gw-info.net) provides the following table which summarizes the porosity and hydraulic conductivities for various soil strata encountered within its well record database for Southwestern Ontario. It is understood that these values are based on published literature.

Table 9: Lithology and Hydraulic Conductivity

Lithology	Porosity (%)	Hydraulic Conductivity (m/s)
Silt	34 to 61	1×10^{-9} to 2×10^{-5}
Sand	26 to 53	2×10^{-7} to 6×10^{-3}
Gravel (containing > 30% gravel)	24 to 44	3×10^{-4} to 3×10^{-2}

The hydraulic conductivity values for the silt and sand soils would generally be considered relevant to the soil conditions encountered at the site. However, the published data provides a broad range of values which require further refinement. Additional analyses by correlation of gradation results and by conducting single well response tests have been carried out and are presented in the following sections.

4.4.2 Single Well Response Tests

Single Well Response Tests (rising head tests) were conducted in the monitoring well installed at boreholes BH1 and BH5, on December 19, 2018, to estimate the hydraulic conductivity of the overburden formations at the site, and to validate the estimated hydraulic conductivity values determined from the gradation analyses described above. The SWRTs provide an estimate of the hydraulic conductivity values of the geological formation within the immediate area around the well screens. These wells were screened within the natural sandy subgrade soils.

Groundwater level measurements were taken prior to the start of the test. A submersible pressure transducer with a data logger was inserted into to each monitoring well to measure the change in water level for the duration of each test. Use of the data logger allows for high frequency data collection and increased accuracy, compared to manual measurements during the testing.

Hydraulic conductivity values were estimated from field SWRT data as per the Hvorslev's method (refer to worksheets provided in Appendix D). A summary of the hydraulic conductivity values estimated from the field SWRTs are provided in the following table.

Table 10: Single Well Response Test Results

Well ID	Well Depth, m bgs	Screen Length, m	Formation Screened	Estimated Hydraulic Conductivity, m/s
BH1	6.10	3.05	Compact fine sand	2.86×10^{-5}
BH5	6.10	3.05	Compact sandy silt	4.60×10^{-6}

The calculation worksheets in Appendix D allow for a gravel pack correction, using an equivalent radius (R_{equiv}) to correct for the filter pack around the well screen. The use of Single Well Response Test information should be subject to further review before it is used to support detailed design. As such, changes in the soil composition and consistency may occur as a result of site grading activities, and additional field testing is anticipated to validate the soil permeability within specific parts of the site. Additional field testing and larger scale pump tests may also be utilized to confirm the reliability of soil permeability data.

4.4.3 Grain Size Analyses

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.

Based on the gradation results (presented in Section 4.2), the following values for saturated hydraulic conductivity and infiltration rate have been calculated for the collected samples. Hazen's method was used to correlate the grain size analysis to the hydraulic conductivity of the sand soils. This correlation is based on the following relationship:

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

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 11: Hydraulic Conductivity & Factored Infiltration Rates

Parameter	Fine Sand, some Silt		Sandy silt				Silt, trace Sand	
	BH1, SA6	BH7, SA4	BH2, SA4	BH4, SA5	BH5, SA4	BH8, SA1	BH3, SA4	BH5, SA6
d_{10} (mm)	0.07	0.06	0.034	0.020	0.022	0.017	0.021	0.020
d_{60} (mm)	0.12	0.10	0.06	0.05	0.04	0.06	0.41	0.049
Saturated Hydraulic Conductivity (m/s)	$4.9x10^{-5}$	$3.6x10^{-5}$	$1.2x10^{-5}$	$4.0x10^{-6}$	$4.8x10^{-6}$	$2.9x10^{-6}$	$4.4x10^{-6}$	$4.0x10^{-6}$
Factored Infiltration Rate (mm/hr)	52	48	35	27	28	24	27	27

The above factored infiltration rates were calculated using correlation from TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide protocol which references Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario. A Factor of Safety of 2.5 has been applied, in accordance with TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide protocol.

5.0 GEOTECHNICAL COMMENTS AND RECOMMENDATIONS

A Concept Plan for the residential subdivision is provided on Drawing 1, in Appendix A. It is understood that current development plans include the creation of approximately 96 single family lots and 4 multi-family blocks, accessed with local roadways connecting to Rougham Road, and the future proposed subdivision located to the east. The site is expected to be serviced with municipal water and sewers.

Boreholes drilled at the site generally revealed a layer of topsoil underlain by natural fine sand and sandy silt. Based on stabilized groundwater levels measured in the monitoring wells, shallow groundwater is located approximately 0.7 to 2.8 m below existing ground surface. Shallow groundwater conditions have been recorded at the site under spring high conditions, with water levels near surface, particularly near the wooded areas.

The following sections of this report provide geotechnical comments and recommendations to assist with design and construction of the proposed residential development.

5.1 Site Preparation

5.1.1 Site Grading Activities

Based on existing site grades, it is expected that some minor site grading activities will be required. Topsoil stripping is anticipated throughout the area to be developed. In general, this is expected to require the removal of about 100 to 250 mm of surficial topsoil. Thicker topsoil areas may be present in proximity to existing wooded areas, and where local depressions are present at the site, this is particularly noteworthy in the southeast corner of the site, where the existing drainage system outlets into an open drain.

Surficial topsoil may be stockpiled on site for possible re-use as landscaping fill. In the event that material is disposed of offsite, testing of the material for transport should conform to MECP Guidelines and requirements.

Where exposed subgrade soils are approved by the geotechnical consultant, and grades need to be raised to reach design elevations, it is anticipated that grades will be restored using structural / engineered fill. Engineered fill should consist of suitable, compactable, inorganic soils, which are free of topsoil, organics and miscellaneous debris. For best compaction results, the fill material should have a moisture content within about 3 percent of optimum, as determined by Standard Proctor testing.

The placement of the engineered fill should be monitored by the geotechnical consultant to verify that suitable materials are used, and to confirm that suitable levels of compaction are achieved. Engineered fill material should be placed in maximum 300 mm (12 inch) thick lifts and uniformly compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD). Additional notes regarding engineered fill placement are provided on Drawing 7 in Appendix A.

5.1.2 Excess Soil Management Considerations

In December of 2019, the Ministry of Environment, Conservation, and Parks (MECP) released a regulation under the Environmental Protection Act, titled *On-Site and Excess Soil Management* to support improved management of excess construction soil. The current version of Regulation 406/19 includes recent amendments (December 2022), and the regulation is now fully implemented.

Excess soil is defined as material that was generated during construction activities at a Site but will not be needed for grading, fill, or other purposes and therefore needs to be transported off-Site. The regulation requires a project leader to comply with specific requirements before removing excess soil from a project area.

Generally, these requirements include:

- Preparation of an Assessment of Past Uses Report which is similar to a Phase One Environmental Site Assessment for the source site, to evaluate the presence of potentially contaminating activities which may have resulted in the potential for impacted soil or groundwater conditions to be present at the source site;
- Preparation and implementation of a Sampling and Analysis Plan which outlines the suggested sample locations and sampling intervals, analytical sample testing parameters, and sampling frequency;
- Preparation of a Soil Characterization Report, following the soil sampling and analytical testing;
- Preparation of an Excess Soil Destination Assessment Report which identifies where excess soils can be disposed offsite, including a review of Beneficial Reuse Sites, if the developer and/or their contractor have a potential re-use site being considered; and,
- Development and implementation of a tracking system.

The site is within a predominantly agricultural area. LDS is not currently aware of the site being considered as an “enhanced investigation project area” as defined in O.Reg. 406/19 and O.Reg. 153/04, as amended. Provided that no significant environmental concerns were identified with respect to current and/or former activities at the subject properties, the proposed development may be considered to qualify for an exemption from the regulatory requirements (preparation of planning documents, soil characterization, and tracking requirements), as noted in Section 8 of the Regulation.

Offsite disposal of excess soils may still require soil characterization and analytical testing to satisfy the receivers of excess soil. Coordination with their QP will be required to ensure that their testing requirements are satisfied prior to transporting soils offsite for beneficial reuse or disposal off-site.

It is noted that under the Regulation, the onus is on the Excess Soil Source Site to carry out environmental soil quality testing for the removal and transport of their excess soils. The property owner is expected to retain a Qualified Person (QP) to assist in the preparation of the aforementioned documents and in the soil characterization work (environmental testing on select soil samples), prior to any excess soils being removed from the Site.

In the event that the site requires imported fill material to achieve design grades, the site would be characterized as a Beneficial Re-Use Site. As such, a Qualified Person (QP) will need to be retained to prepare an Excess Soil Destination Assessment Report (ESDAR), which outlines the geotechnical requirements for beneficial reuse of imported materials onsite along with the environmental soil quality criteria (including the applicable O.Reg. 153/04 Site Condition Standards) for material which is appropriate to be accepted at the Site. In this case, material meeting the O.Reg. 406/19 Table 2.1 Site Condition Standards, Residential/Parkland/Institutional Land Use (or better) is generally considered appropriate for this site.

5.2 Excavations and Groundwater Control

5.2.1 Excavations

Excavations for the proposed buildings and site services are generally expected to extend through the topsoil, and will terminate within the natural sand or sandy silt soils.

All work associated with design and construction relative to excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). Based on results of the geotechnical investigation and in accordance with Section 226 of Ontario Regulation 213/91, native sand and sandy silt deposits are classified as Type 3 soil. For excavations, which extend through or terminate in Type 3 soil, temporary excavation side slopes must be cut back at a maximum inclination of 1H:1V from the base of the excavation. It should be noted that where excavations extend below the stabilized water table, the natural sand may behave as a Type 4 soil, and excavation sidewalls may be expected to slough to slopes flatter than 3H:1V. The wet sand deposits may be classified as Type 3 soil if adequate dewatering is carried out.

In the event that construction occurs in seasonally wet conditions or when frozen soil conditions are present, care will be required to maintain safe excavation side slopes, and suitable excavation bases. The contractor should use a reasonable effort to direct surface run-off away from open excavations.

4.2.2 Excavation Support

If space restrictions at the site do not allow for conventional open cut without risk of undermining, or where excavation sizes are to be limited, the use of adequate bracing or shoring may be required. In the natural subgrade soils, bracing will not normally be required if the structures are behind a 45-degree line drawn up from the near edge of the excavation.

If the construction excavation side slopes recommended above cannot be maintained due to lack of space or close proximity of other structures, an engineered excavation support system must be used. Minimum support system requirements for steeper excavations are stipulated in Sections 234 through 242 of the Act and Regulations. The shoring system must be designed to be internally (overturning, and sliding) and externally stable (slope stability/base heave).

A prefabricated trench box may be used for service trench excavations, provided that it is designed (by a professional engineer) to withstand the soil and hydrostatic loading (if applicable). Based on the field and laboratory testing during the present geotechnical investigation and our experience with similar soils, the following soil parameters are recommended for the design of the engineered shoring system.

Table 12 - Soil Parameters for Excavation Support

Soil	φ	γ (kN/m^3)	K_a	K_o	K_p
Compact Silt/Silt Till	28	19.5	0.36	0.53	2.78
Compact Sand and Silty Sand	30	19.5	0.33	0.50	3.15
Compact Granular ‘B’ (OPSS 1010)	32	22.0	0.31	0.47	3.25

Notes:
Φ denotes internal friction angle (degrees)
γ denotes soil bulk unit weight
K_a denotes active earth pressure coefficient (Rankine, dimensionless)
K_o denotes at-rest earth pressure coefficient (Rankine, dimensionless)
K_p denotes passive earth pressure coefficient (Rankine, dimensionless)

In the event that imported fill material is present near the excavation which vary materially from the above soils, the geotechnical consultant should review the soil conditions to confirm the design parameters.

5.3 Groundwater Control

Based on the results of the investigation, the groundwater level is relatively shallow, with typical summer/fall water levels encountered at approximately 0.7 to 2.87 m below existing ground surface, with seasonal high conditions anticipated to be near surface in some parts of the site.

Conventional groundwater control methods are expected to be suitable for shallow excavations which remain above the groundwater table at the site. Excavations which extend below the groundwater table will require positive groundwater control and a comprehensive groundwater dewatering plan. Infrastructure projects and nearby residential developments in the south end of Mt. Brydges have utilized vacuum well point systems to temporarily lower the stabilized groundwater table during construction. Permits to Take Water issued by MECP have been in excess of 10 million litres per day.

5.3.1 Permit to Take Water Requirements

For substantial excavations which extend below the groundwater table, a system of well points is typically installed along or around an excavation. It is generally accepted that the height to which water can be drawn down using a single stage well point system is approximately 6 metres. To function at greater depths, well points can be installed in pre-cut sections or in multi-stages as the excavation proceeds. Specific dewatering requirements for this site can be identified when design grades, servicing design and founding levels are identified.

Regardless, groundwater control measures at the site should help to maintain stable excavated slopes; reduce saturated soil conditions to allow for possible reuse of excavated material; and provide a dry and stable base for excavations and construction operations. A dewatering plan should be submitted by excavating contractors involved in site servicing work for the subdivision. To assist in preparation of the dewatering plan, consideration should be given to carrying out a series of pre-tender test pits for contractors to obtain a better appreciation of the behavior of excavations and to confirm dewatering requirements. Contractors (including specialist dewatering contractors) who might be involved in the job should witness these test pits.

It should be noted that for projects requiring positive groundwater control with a removal rate in excess of 50,000 litres per day, a Permit to Take Water (PTTW) or a submission to the Environmental Activity and Sector Registry (EASR) will be required. For this site, it is anticipated that a Category 3 PTTW will be required for groundwater control, expected to be over 400,000 L/day. PTTW applications are submitted to and approved by MECP according to Sections 34 and 98 of the Ontario Water Resources Act R.S.O. 1990 and Water Taking and Transfer Regulation O. Reg. 387/04.

Some of the factors which directly contribute to the volume required for a Permit to Take Water include the following:

- Localized variations in soil conditions;
- Seasonal influences on stabilized water table;
- Design depth for excavations;
- Length and staging to advance continuous open-cut excavations (i.e.: excavations for site servicing); and,
- Methodology and experience of the contractor.

A Construction Dewatering and Discharge Plan will be required for the PTTW submission. LDS can assist with the preparation of these documents. Preparation of the Construction Dewatering and Discharge Plan requires information from the contractor carrying out the excavation work, and the contractor responsible for providing groundwater control. The construction methodology, including details for the typical length and depth of service trenches, information about excavation support or cut-off systems (such as trench liner boxes) which may be utilized, and the method of groundwater control which will be utilized. This information is included, to inform the discussion which is provided in the Dewatering Plan, which is expected to include discussion on potential impacts to soil settlement, impact to existing groundwater users and surface water features, along with consideration for extreme weather events. The Plan will also identify the discharge location for pumped water, including sediment and erosion control measures which will be utilized where water is contained onsite, or where filtering of discharge water is planned, for water being outletted to nearby drains or municipal infrastructure.

The existing wells at the site may be used for future groundwater monitoring; however, it is noted that of the original 5 monitoring wells which were installed at the site, only 3 wells remain.

5.3.2 Construction Dewatering Zone of Influence

As a preliminary assessment of the zone of influence for potential construction dewatering activities, the Sischart and Kryieleis method has been utilized, which is based on an empirical relationship with the amount of groundwater lowering and the soil permeability.

The zone of influence is calculated using the following equation:

$$Ro = 3000\,(H-h)(k)^{1/2}$$

where, H = high water level, m
h = lowered water level, m
k = soil permeability, m/s

For the purposes of this preliminary analyses, a soil permeability of 8.2×10^{-6} m/s has been used, based on the geometric mean determined from the correlations with the gradation analyses, and the water levels have been measured relative to a lower grey silt layer, documented in some of the nearby well records below 9.5 m depth. The following table summarizes the range of distances applicable to various depths of the groundwater lowering, based on variable soil conditions.

Table 13: Zone of Influence Estimates

Zone of Influence Scenario	Effective Lowering			
	1.0 m bgs	2.0 m bgs	3.0 m bgs	4.0 m bgs
Geometric mean of silty sand & sandy silt soils	8.6 m	17.2 m	25.8 m	34.4 m
Geometric mean of sand soils	19.4 m	38.9 m	58.3 m	77.8 m

The zone of influence calculations provided above allow for a range of soil permeability values, allowing for changes in methodology of determining the soil permeability, as well as allowing for variations in the soils which range from sandy silt to silty sand. The use of cut-off walls or similar type systems may be considered for the purposes of minimizing impacts to the stable shallow groundwater table during construction, if a need is identified to limit the zone of influence from open excavations.

Detailed design information, including site grading information is imperative to have to more accurately determine the zone of influence. Cut-fill activity to balance the site may impact exposed soils, and the relative depth of the shallow groundwater to the finished grade. Field testing can be conducted to confirm design parameters, so that actual site conditions are accurately reflected.

While active construction dewatering occurs at the site, a program which includes turbidity monitoring may be appropriate to confirm that the quality of discharge water will not have adverse impacts to sensitive receptors. In the event that water discharged from the site is considered to have an elevated turbidity level, associated construction activities should be halted until remedial measures can be implemented. Such measures may include enhanced or more robust sediment and erosion control measures, incorporating pooling areas and measures that will reduce suspended solids, temporary storage measures to prevent off-site discharge.

5.4 Building Components

5.4.1 Foundation Design

All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft.) of soil cover or equivalent insulation. For design of footings on the natural subgrade soils below 1.2 m below existing grades (design frost depth), an allowable bearing pressure (net stress increase) of 120 kPa (2500 psf) can be used for design of footings.

Due to the presence of shallow groundwater encountered at the site, and variable loose to compact soil conditions, it is recommended that exposed subgrade soils at the design footing level be thoroughly recompacted to verify soil bearing capacity.

Footings at different elevations should be located such that higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the closest edge of the lower footing. It is important to note that if servicing easements are located between residential lots, servicing excavations which encroach on the building foundations are checked to ensure that they do not undermine building foundations.

Verification of the footing base conditions should be undertaken by the geotechnical engineer at the time of excavation. In the event that unsuitable soils are removed and grades are restored using engineered fill, a design bearing capacity on approved engineered fill of 120 kPa is available. Where engineered fill is placed over wet subgrade soils, it is recommended that engineered fill be comprised of approved sand and gravel fill to ensure proper compaction is achieved and to minimize problems associated with instability resulting from the use of vibratory equipment over sensitive subgrade soils.

Provided that the stability of soils exposed at the founding level is not compromised as a result of construction activity, precipitation, cold weather conditions, etc., and design bearing pressures are not exceeded, the total and differential settlements of footings are expected to be less than 25 mm and 19 mm, respectively.

It should be noted that the recommended bearing capacities have been calculated by based on observations of soil and groundwater conditions within the borehole program at the site. Where variations occur between borehole locations, and during construction, site verification by the geotechnical consultant is recommended to confirm soil conditions and verify soil bearing capacity.

5.4.2 Concrete Slab Construction

Concrete floors may be constructed using conventional concrete poured slab techniques, following the review and approval of the subgrade soils.

In preparation for the construction of the floor slab, any unstable (loose) fill material should be removed and recompacted (as noted previously) where founding soils will support the floor slab. In the event that the exposed subgrade soils are wet they will exhibit a greater sensitivity to disturbance. Structural fill placed below the concrete floor slab should be comprised of inorganic soils, placed and compacted in uniform lifts, to a minimum of 98 percent SPMDD.

Care should be taken to protect the subgrade below the floor slab during construction, by limiting construction traffic on the prepared subgrade soils. In addition, if the exposed subgrade soils are exposed to inclement weather conditions (i.e. rain, snow, freezing conditions), some remedial works may be required to remove wet, soft, or disturbed soils prior to stone and concrete placement.

A moisture barrier, consisting of a minimum 200 mm thick of uniformly compacted 19 mm clear stone should be placed over the approved subgrade. For design purposes, the modulus of subgrade reaction (k) can be taken as 45 MPa/m, for the compacted stone over approved subgrade soils. An alternate configuration of compacted granular material such as OPSS 1010 Granular A may also be considered for the moisture barrier. If alternative materials are proposed for use onsite, the minimum level of compaction and overall design thickness of the moisture barrier layer should be reviewed by the geotechnical consultant.

The water-to-cement ratio of the concrete utilized in the floor slab should be strictly controlled to minimize shrinkage of the slab. Adequate joints and / or the use of fibre reinforcement may be considered by the designer to help control cracking. The sawcut depth for control joints should be ¼ of the slab thickness. The use of super plasticizers should be considered to reduce shrinkage and increase workability of the concrete.

During construction, concrete sampling and testing is recommended to ensure that concrete mix design requirements are satisfied.

5.4.3 Basement Construction

Grading design for the site has been established to help minimize conflicts between building foundations and shallow groundwater conditions. It is noted that the typical design process when determining site grades for each phase of the development started with a target of balancing the amount of cut-fill activity required, which typically raises the ground surface about 1 m. From there, analysis was carried out to assess shallow groundwater conditions, and design grades can adjust to provide additional fill to keep building foundations at or above seasonal groundwater conditions. Where site grades are limited by natural features and existing grades to be matched at boundary conditions, the design of the houses can be modified to provide partial basements or look-out lots to adjust the design founding level.

Basement floors can be constructed using cast slab-on-grade techniques provided that subgrade is stripped of unsuitable material. It is recommended that a minimum 200 mm (8 inch) thick compacted layer of 19 mm (¾ inch) clear stone be placed between prepared subgrade and the floor slab to serve as a moisture barrier. Subfloor drains (connected to the sump pit) may be required if high groundwater levels encroach on the basement level.

The portion of exterior basement wall below finished groundwater level should be damp-proofed and designed to resist a horizontal earth pressure ‘P’ at any depth ‘h’ below the surface as given by the following expression:

$$P = K (\gamma h+q)$$

where, P = lateral earth pressure in kPa acting at depth h;
γ = natural unit weight, a value of 20.0 kN/m^3 may be assumed;
h = depth of point of interest in m;
q = equivalent value of any surcharge on the ground surface in kPa.
K = earth pressure coefficient, assumed to be 0.4

Installation of perimeter drains will be required for basements at the Site. The above expression assumes that the perimeter drainage system prevents build-up of any hydrostatic pressure behind the wall. Subfloor drains may also be required to facilitate foundation drainage. This requirement can be reviewed when additional grading information is available.

Consideration may be given to enhanced damp-proofing measures (such as subfloor drains), where there is reasonable concern that the basement level may conflict with the high groundwater level on an intermittent basis.

In general, native sand and sandy silt soils excavated from the building footprints (from above the stabilized water level) are generally expected to be suitable for re-use as foundation wall backfill.

5.4.4 Seismic Design Considerations

Subsoil and groundwater information at the Site have been examined in relation to Section 4.1.8.4 of the Ontario Building Code (OBC) 2012. The subsoils expected below the buildings will generally consist of compact silty sand and sandy silt overlying silt till soils.

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2012 indicated that to determine the site classification, the average properties in the top 30 m are to be used. The Site Classification recommendation is based on the available information as well as our interpretation of conditions at and below the boreholes, and based on a review of geological mapping, and our knowledge of the soil conditions in the area.

Based on the above assumptions, interpretations in combination with the known local geological conditions, the Site Class for the proposed development is classified as “C” as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2012. In the event that a higher Site Classification is being sought by the structural design engineer, additional deep boreholes and / or multichannel analysis of surface waves (MASW) testing would be required to determine if the soil conditions below the current depth of exploration can support a higher Site Classification.

5.4.5 Concrete Recommendations

CSA A.23-1.04 provides minimum requirements for concrete, including Exposure Class, maximum water to cement ratios, allowable air entrainment, slump, temperature requirements, etc. The design of the building foundations should have regard to the above referenced standard, and should be reviewed by the designer for conformance to CSA standards.

Concrete sampling and testing for foundations and concrete slabs (in accordance with CSA A23.1-04) is recommended.

5.5 Site Services

Depending on final design grades, subgrade soils beneath new services are generally expected to consist of compact sand. Seasonally shallow groundwater conditions are anticipated at the site. Although no bearing problems are anticipated for flexible or rigid pipes founded on natural deposits, localized base improvement along the trench bottom may be required for excavations which terminate in wet subgrade soils. The extent of base improvement or stabilization is best determined in the field during construction, with consultation from LDS’ geotechnical engineer.

For services supported on native deposits, the bedding should conform to OPS Standards. Bedding aggregate should be compacted to a minimum 95 percent SPMDD. Water and sewer lines installed outside of heated areas should be provided with a minimum 1.2 m of soil cover for frost protection.

A well graded stone layer may be used in service trenches as bedding below the spring line of the pipe if necessary to provide stabilization to the excavation base in wet subgrade soils, where encountered. Geotextile may be considered for wrapping the pipe and to limit movement of fines from surrounding soils into the bedding material. Potential locations for use of stone bedding can be identified through site inspection during construction, and will vary across the site due to seasonal conditions and variations in perched groundwater conditions.

Requirements for backfill in service trenches, etc. should also conform to Municipal and OPS Standards. A program of in situ density testing should be set up to ensure that satisfactory levels of compaction are achieved. Based on the results of this investigation, excavated material for trenches will generally consist of silty fine sand. Select portions of this inorganic material may be used for construction backfill provided that reasonable care is exercised in handling the material. In this regard, material should be within 3 percent of the optimum moisture as determined by the Standard Proctor density test. Stockpiling of material for prolonged periods of time should be avoided. This is particularly important if construction is carried out in wet, adverse weather.

Soils excavated from below the stabilized groundwater table may be too wet for re-use as backfill, unless adequate time is allowed for drying, or if material is blended with approved dry fill; otherwise, it may be stockpiled onsite for re-use as landscape fill, or disposed of off-site.

Backfill above bedding aggregate can consist of excavated (inorganic) soils, compacted in maximum 300 mm thick lifts to a minimum of 95 % SPMDD. A program of in situ density testing should be set up to ensure that satisfactory levels of compaction are achieved.

5.6 Pavement Design

Areas to be paved should be stripped of any obviously unsuitable or unstable material to design subgrade level. The exposed subgrade must then be thoroughly proof-rolled and reviewed by the geotechnical consultant. In the event that loose or soft areas are noted, additional work may be required to sub-excavate and replace unstable soils with suitable compactable material. This work should be done under the supervision of the geotechnical consultant. In general terms, compacted soils supporting site pavements should be compacted to a minimum level of 98 percent SPMDD.

Provided that the preceding recommendations are followed, pavement thickness design requirements given in the following table are recommended for the anticipated subgrade conditions and traffic loading.

Table 14: Pavement Design Thicknesses

Pavement Component	Minimum Design Thicknesses		Compaction Requirements
	Rougham Road	Local Roads	
Asphaltic Concrete	40 mm HL 3 80 mm HL 8	40 mm HL 3 50 mm HL 8	92.0 – 96.5 % MRD
Granular A Base	150 mm	150 mm	100% SPMDD
Granular B Subbase	400 mm	350 mm	100% SPMDD

Other granular configurations may be possible provided the granular base equivalency (GBE) thickness is maintained. These recommendations on thickness design are not intended to support heavy and concentrated construction traffic, particularly where only a portion of the pavement section is installed. If frequent construction traffic is anticipated while only a portion of the site pavements are in place, or if construction is undertaken in poor weather conditions, thickening of the granular subbase may be appropriate and can be reviewed during construction, by the geotechnical consultant.

In the event that turning lanes are planned, the existing topsoil and/or fill material which may be present in the shoulder area should be removed, to expose suitable subgrade soils. Fill placed adjacent to the existing roadway should be placed in maximum 300 mm thick lifts, and uniformly compacted to a minimum of 98 percent SPMDD. In this area, and where the roadway from the subdivision intersects the existing roads, subgrade levels and pavement components should be tapered to match / tie-into existing pavement structures to minimize differential settlements at the transition from existing to new pavement.

Where new pavements abut existing pavements, it is recommended that the subgrade level be matched to the existing pavement structure, to minimize differential settlements at the transition from existing to new pavements.

It is recommended that a program of inspection and materials testing (including laboratory analyses and compaction testing) be carried out during construction to confirm that geotechnical requirements are satisfied.

- Samples of both the Granular 'A' and Granular 'B' aggregates should be checked for conformance to OPSS 1010 prior to use on site, and during construction.
- The asphaltic concrete paving materials should conform to the requirements of OPSS 1150. The asphalt should be placed in accordance with OPSS 310.
- Specified compaction levels are identified in the table, above.

Good drainage provisions will optimize pavement performance. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. In low areas, consideration may be given to extending short stub drains at the catchbasin located to intercept excess subsurface moisture.

5.7 Curbs and Sidewalks

Concrete for any new exterior curbs and sidewalks should be proportioned, mixed placed and cured in accordance with the requirements of OPSS 353 and OPSS 1350.

During cold weather (when the air temperature is at or is likely to fall below 5°C within 96 hours of concrete placement) the freshly placed concrete must be covered with insulating blankets to protect against freezing, as per OPSS 904. Ice and snow must be removed from the area where concrete is to be placed and the concrete must not be placed against frozen ground. All cold weather protection material shall be on site prior to each concrete placement.

Subgrade for sidewalks should consist of undisturbed natural soil or well compacted fill. A minimum 100 mm thick layer of compacted (minimum 100 percent SPMDD) Granular 'A' is recommended below sidewalk slabs. It is recommended that Granular 'A' material extend at least 150 mm beyond the edges of the proposed sidewalk. The subgrade and granular base should be prepared in accordance with the requirements of OPSS 315.

Sidewalks should be designed with a minimum 100 mm thickness. The concrete for the sidewalk should follow OPSS 1350 design standards. Field sampling and testing of concrete shall be according to OPSS 904.

5.8 Construction Monitoring

5.8.1 Inspection and Testing

An effective inspection and testing program is an essential part of construction monitoring. The Inspection and Testing Program for site preparation, servicing, foundations and site pavements typically include the following items:

- Subgrade examination prior to engineered fill placement and footing base confirmations for any foundations constructed on engineered fill;
- Inspection and materials testing during engineered fill placement (full-time monitoring is recommended) and site servicing works, including soil sampling, laboratory testing, and compaction testing;
- Inspection and testing during road construction, including compaction testing and laboratory testing for pavement components and concrete sampling and testing for curbs; and,
- Inspection and materials testing for base and surface asphalt.

The municipality will require inspection and testing records to verify that project specifications have been satisfied for site servicing and road construction.

5.8.2 Sediment and Erosion Control

Sediment and erosion control measures will be required during construction, particularly around the perimeter of the site, to contain sediment and prevent discharge towards the neighbouring properties. The design of the Sediment and Erosion Control Plan for the site will need to incorporate suitable erosion control practices and strategies which are suitable to site conditions, and have regard for contingency measures planned in the event that the integrity of the system is compromised.

The following table (Table 15, presented on the next page) summarizes general mitigation measures which are suggested as best management practices. Topsoil stripping should be conducted in a logical sequence in order to minimize the areas where soil is exposed. Topsoil removal should be organized and timed according to the schedule for grading and development works within the overall property.

An inspection and reporting schedule should be incorporated into the Sediment and Erosion Control Plan. Contractors working at the site will be required to adhere to the approved Plan. Adjustments to the plan may be required to adapt to site conditions and seasonal conditions to ensure that the system and erosion control strategy remains effective through the various stages of construction. The frequency of inspections will depend on weather and site conditions. The following minimum inspection intervals are recommended:

- Before and immediately after rainfall and snowmelt events (timing for inspections before are based on predicted weather forecasts);
- Daily during extended rain or snowmelt periods;
- Daily during any construction activity that would potentially yield significant run-off volumes or otherwise impact the quality of the run-off leaving the site;
- Daily while deficiencies are present which fail to contain, filter or otherwise treat run-off, or contribute to sediment loading in surface water;
- Weekly during dry periods while construction activity is occurring at the site; and,
- Monthly during inactive periods (> 30 days).

Consultation with local approval authorities is recommended to confirm inspection, monitoring, and reporting requirements.

The following table outlines a number of recommended best management practices to help alleviate and prevent uncontrolled sediment release from the site.

Table 15: Best Management Practices for Sediment Containment

Practice / Task	During Site Grading	During Site Servicing	During Building & Pavement Constructions	Following Construction
Measures to Protect Off-Site Sediment Release				
Establish controlled construction entrance/exit points, incorporating the use of mud-mats to help control the amount of loose soil being carried offsite from construction vehicles	✓	✓		
Prevent wind-blown dust.	✓	✓	✓	
Installing perimeter ESC measures such as silt fence and/or silt sock around temporary soil stockpiles, with dedicated points of access clearly marked onsite.	✓	✓		
Build-up boulevard areas to help limit sediment-laden stormwater run-off (from open or partially constructed areas) from discharging into catchbasins and stormwater infrastructure, and regular inspection and maintenance of silt bags/geotextile filters installed in catchbasins.			✓	✓
Measures to Protect Natural Features				
Monitoring of discharge water (for water quality – turbidity) from stormwater run-off and construction dewatering activities.	✓	✓	✓	
Delineate work areas to limit construction activities encroaching into the natural heritage features and setback areas, to prevent unnecessary vegetation removal.	✓	✓	✓	
Dedicated fuel storage and equipment fueling areas located away from natural or otherwise sensitive features. Contractors should have an emergency spills management plan.	✓	✓		
Re-establishing vegetative cover in disturbed areas. In areas which are susceptible to erosion, additional measures may include the use of sod, hydroseeding, or mulch to protect the exposed subgrade soils.	✓	✓	✓	✓
Maintain perimeter silt fence (and other perimeter ESC measures) in place until disturbed areas and lots are sodded/seeded, and vegetative cover has become established.			✓	✓

Removal or decommissioning of ESC measures should not be carried out until site conditions are stabilized, and/or construction is complete. I

in accordance with Provincial Regulations, in the event of an uncontrolled sediment discharge offsite, the incident must be reported to the Ontario Spills Action Centre. Reporting requirements include the date and time of the reportable incident, including the source, current status and impact which has been identified. Other pertinent details, such as weather conditions should also be included in the reporting.

6.0 WATER BALANCE ASSESSMENT

The water balance assessment has been prepared by LDS and is presented in detail in the Conceptual Stormwater Management Report, dated March 6, 2019. The overall property is approximately 20.7 hectares in size, with 2.36 ha planned for streets, 7.85 ha planned for single detached residential and multi-unit residential purposes, 0.31 ha for a SWM facility, and the remainder planned as open space for parkland and natural heritage. The report details the water balance analyses which was carried out for the property under existing conditions and under the proposed development scenario at the site. The following table summarizes the recommended elements of the assessment, and provides a reference to the corresponding material within this report.

Table 16: Elements of Water Balance Assessment

Conservation Authority Recommended Element of the Water Balance Assessment	Reference
Obtain precipitation values from a reliable source such as Environment Canada Meteorological Services for the area (utilize closest station with adequate data)	Environment Canada Climate Normals 1981 – 2010 London Airport Weather Station, Ontario
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 are provided in Appendix E, which reference values which are based on Table 3.1 of the MECP Stormwater Management Planning and Design Manual, and modified to reflect site conditions, as described.
Calculations of impervious areas that reflect actual conditions based on the proposed site plan or a reasonable range of impervious areas used in those cases where only a conceptual development plan is provided	Total impervious area used for the pre- and post-development water balance calculations are based on existing conditions, and the concept plan provided by the client.
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, impervious areas, grading and topography are taken into account when estimating the pre- and post-development water balance components, and are presented on the Water Balance Calculation Worksheets in Appendix E.
Grain size analysis for both the fill material and on-site soils to confirm fill material is similar to existing soil conditions (maybe recommended)	Soil permeability values are based on correlation with collected sample gradation results.
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 rationale used to delineate catchment areas, and to estimate infiltration / runoff values within the zones for both pre- and post-development areas are summarized in the following paragraphs.
Figure of catchments used within the pre- and post-development water balance	Pre and post development water balance catchment areas are provided on the Plans provided in Appendix E.
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 summarized in table format in the following sections of this report.

6.1 Catchment Areas

Under existing conditions, the site is comprised of wooded areas and arable land. Catchment areas under existing conditions were determined based on surface topography, identifying catchment areas which direct flows towards the woodlot located at the northeast corner of the site, towards the central woodlot, and towards the existing drain in the southeast part of the site. Under existing site conditions, six catchment areas have been identified. These are denoted as Catchment 101 through 106. The limits of these Catchment Areas are shown on Pre-Development Drawing, in Appendix G, and described in Table 16, below.

Table 17: Pre-Development Catchment Areas

Catchment	Area	Description
101	2.20 ha	Southwest corner of site, arable land, draining towards Parkhouse Drive drainage ditch.
102	5.10 ha	Central area in the south half of the site, arable land and southeast wooded area, draining towards wooded area and ravine system.
103	0.70 ha	Southeast strip in the south half of the site, arable land, draining east towards neighbouring lands.
104	7.80 ha	Central woodlot and a portion of arable lands.
105	2.90 ha	West part of north half of site, arable land, draining towards Rougham Road drainage ditch.
106	2.00 ha	Northeast corner of the site, arable land and north woodlot, draining towards north woodlot.

Under the proposed development plans, the area is subdivided into five catchment areas, denoted as Catchment 201 through 205. A description of the catchment areas, and the specific stormwater management features associated with each catchment are described in Table 17, below.

Table 18: Post-Development Catchment Areas

Catchment	Area	Description
201	1.40 ha	Existing wooded area in northeast corner of site, and rear half of Lots 10-17, Designated as 15% impervious for analyses.
202	3.70 ha	Road alignments in the north part of the site, along with front half of perimeter lots and full lots contained with the catchment. Designated as 50% impervious for analyses.
203	8.30 ha	Existing central wooded area, and rear half of Lots 45-54 in the north end of the site. Designated as 5% impervious for analyses.
204	5.10 ha	Roads, single family lots and multi-unit residential lands in the south end of the site. Designated as 50% impervious for analyses.
205	2.10 ha	South ravine wooded area, SWM block, and the rear half of Lots 78-80, and 81-87. Designated as 10% impervious for analyses.

The limits of these Catchment Areas are shown on the Post-Development Drawing, in Appendix G.

6.2 Water Balance Calculations

Due to the hydraulic gradient determined from shallow groundwater water levels at the site, the predominant baseflows which feed into the north woodlot are expected to be upgradient from the proposed development limits - north of the north woodlot. Only minor contributions to the base flows, following localized topography which slopes towards the woodlot in the northeast corner of the site are expected. Onsite contributions to the baseflows which feed into the central woodlot are similarly expected to follow surface topography from the north end of the site. Within the south end of the site, surface water flows appear to drain towards the drainage channel which continues south of Parkhouse Drive. Consideration to maintain local contributions to the baseflows for the woodlot areas has been incorporated into the stormwater management design.

For each Catchment Area within the Site; 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:

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

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

The following table summarizes the predevelopment water balance volumes for infiltration and run-off which is directed towards the wooded areas under existing (pre-development) conditions.

Table 19: Pre-development Volumes – Baseflow for Wooded Areas & SW Ravine

Receiver	Catchment	Area (ha)	Estimated Infiltration (m^3/yr)	Evapotranspiration (m^3/yr)	Runoff (m^3/yr)
North Woodlot	Catchment 106	2.00	6728	10,849	2,883
Central Woodlot	Catchment 104	7.8	28,623	44,015	7,156
Southwest Ravine	Catchment 101, 102, 103, 105	10.9	36,666	59,127	15,714

Under post-development conditions (over the various stages), stormwater flows from the south end of the site (in part) are directed towards a new stormwater management facility in the southeast part of the site, and towards the drainage ditch along the east side of Rougham Road, in the north part of the site. Impervious areas for all post development catchments range between 5 and 50%, depending on the land-use.

Within the proposed development limits of the site, the post-development volumes are summarized in the following table.

Table 20: Post Development Volumes (based on proposed development limits)

Receiver	Post Development Scenario				
	Catchment	Area (ha)	Estimated Infiltration (m^3/yr)	Evapotranspiration (m^3/yr)	Runoff (m^3/yr)
North Woodlot	Catchment 201	1.40	4,367	7,900	2,055
Central Woodlot	Catchment 203	8.30	28,935	46,837	9,137
Southwest Ravine	Catchment 202, 204, 205	10.9	34,440	26,247	50,820

A comparison of infiltration and run-off rates for the pre-development conditions and under the post development conditions are summarized in the following table, and identifies that the estimated infiltration and run-off values contributing to the north wooded area have a deficit compared to predevelopment conditions. Infiltration and run-off values increase for the central woodlot, indicating that baseflows can be maintained and enhanced under post development conditions. The southwest ravine has a decrease in infiltration contributing to baseflows, however the run-off and stormwater management facility will receive increased run-off, as shown in the table below.

Table 21: Net Changes to Water Balance Parameters

Receiver	Net Change		
	Estimated Infiltration (m^3/yr)	Evapotranspiration (m^3/yr)	Runoff (m^3/yr)
North Woodlot	⇩2,361	⇩ 2,949	⇩ 828
Central Woodlot	⇧ 312	⇧ 2,822	⇧ 1,928
Southwest Ravine	⇩ 2,226	⇩ 32,880	⇧34,106

It is noted that a feature-based water balance was carried out as part of the Edgewood Subdivision Hydrogeological Assessment which considers the cumulative effects of both the Edgewood Subdivision and Forest View Subdivision developments on the natural features, including the wooded areas and receiving streams/drains located south of Parkhouse Drive. Results of that analysis are available in the following report prepared by LDS: *Consolidated Report and Construction Monitoring Program, July 10, 2023, LDS Project No. GE-00103*, which previously submitted to the Municipality of Strathroy-Caradoc and their peer review team.

6.3 SWM Strategy Considerations

To increase post development infiltration and evapotranspiration volumes, low impact development (LID) measures can be incorporated into the stormwater design plan/strategy for the proposed development. From a quantitative standpoint, incorporating effective at-source infiltration structures into final land development design as part of a storm water management strategy is primarily dependent on (but not limited to), native soil infiltration rates and depth to seasonal high groundwater table.

The silty sand and sandy silt soils encountered near ground surface have a factored infiltration rate, generally in the range of 25 to 50 mm/hr, as identified previously. Although sandy soils are generally present near surface, they are generally in a moist to wet state. The shallow unconfined aquifer being present at shallow depths in spring high conditions limit the ability to effectively use LID strategies which require separation from the high groundwater table.

The use of grassed swales and/or reduced lot grading can provide benefits in greenspace areas, to extend the amount of time that stormwater is detained on the surface, helping to attenuate run-off by moderating run-off and provide additional infiltration and evapotranspiration opportunities. Such measures may be considered in landscaped areas, outside of ecological buffers identified through the EIS process.

The concept plan includes areas with single loaded roads next to open space and natural environment blocks. Where open space blocks are present outside of the ecological buffers identified through the EIS process, consideration may be given to incorporating localized bioretention features that can provide filtration and enhanced water quality for run-off passing through these areas.

Where site grading activities are planned for the proposed development, onsite review of any materials imported to the site for use is recommended to identify if fill placement can be done to support possible infiltration methods, and to predict the performance of the proposed infiltration structures.

7.0 HYDROGEOLOGICAL DISCUSSION

7.1 Hydrogeologic Setting

The shallow groundwater encountered in the monitoring wells installed at the site contact the shallow unconfined overburden aquifer. This type of aquifer can be interconnected with surface water features, and is generally fed by infiltrated surface water. Shallow overburden aquifers tend to be heavily influenced by site topography. The water level measurements taken at the site are indicative of a southerly groundwater flow direction, which generally follows site topography. It is important to note that shallow groundwater will vary in response to climatic or seasonal conditions, and, as such, may differ depending on the seasonal conditions. Shallow groundwater in unconfined aquifers can be significantly influenced by exceptional and/or sustained rainfall events.

7.2 Water Quality Considerations

Most pollutants in urban runoff are well retained by infiltration practices and soils and therefore, have a low to moderate potential for groundwater contamination. Water quality samples have been obtained from the sites, to establish baseline water quality data. Baseline groundwater conditions (including general chemistry parameters) have been established through sampling conducted in 2018. The results have been discussed previously (Section 4.4.3). LDS is not aware of any contaminant plumes or existing environmental contamination in the vicinity of the site.

Construction activities at the site are generally not expected to impact the chemistry or bacteriological properties of the intermediate depth aquifer. However, the possibility exists that a spill or uncontrolled release of fuel or associated material could occur during construction, which could have a direct impact to the unconfined shallow to intermediate groundwater aquifer, or that sediment discharge could impact the effectiveness of stormwater infrastructure in the area. Additional comments are provided below, in this regard.

Given the naturally low permeability of the predominant silt till soils which underlie the site, the intermediate and deep overburden/bedrock aquifers are not expected to be exposed to contamination from surface sources. However, shallow groundwater contained within the near surface sand/silt soils may be susceptible to water quality impacts as a result of surface activities during construction, since it does not have the benefit of a low-permeability protective soil layer above it.

7.3 Impact Assessment

7.3.1 Potable Wells

Construction dewatering activities are expected to draw water from the shallow unconfined aquifer, with pumped water being discharged to nearby surface water features. This removal and displacement of the shallow groundwater may provide short-term impacts to the water supply. In addition, consideration was given to identifying potential impacts to water quality associated with fuel spills.

No significant long-term impact is anticipated on the wells, either quantitatively and qualitatively. However, consideration has been given to having a mitigation / contingency plan in the event that neighbouring property owners report a perceived impact to shallow water supply wells which are present in the area. Prior to construction, a Work Notice can be circulated to local residents to provide emergency contact information in the event that they a concern resulting from the construction. A temporary water supply can be provided to residents who are not already connected to municipal water service, and experience short-term issues with the quantity of water in their wells, as a result of the site dewatering activities.

In the event that the developer becomes aware of any complaints or concerns, they will be responsible to coordinate an assessment and response with assistance from pertinent consultants and contractors, as necessary. A suggested time frame of 12 to 24 hours is recommended for providing temporary water supply, while the complaint is being assessed.

7.3.2 Natural Heritage Considerations

The woodlots at the site are identified as Significant Natural Heritage Features. As such, the proposed development plans should incorporate appropriate measures to maintain the sustained presence of the natural features which will be maintained. In this regard, baseflow contributions to the wooded areas should be maintained (where possible) under post-development conditions. As noted previously, a feature-based water balance assessment was carried out previously which considers the effects of the Forest View Subdivision development, along with the adjacent Edgewood Subdivision development.

LID measures which are appropriate to the site and soil conditions can be utilized to promote post-development infiltration volumes, and to provide opportunities to provide secondary infiltration for run-off. The location, sizing, and spacing of such features should be reviewed with the site grading and lotting.

In addition, there are best management practices which can be implemented to help mitigate construction impacts to the wooded areas. These may include sediment and erosion control measures, spill contingency and fuel handling planning, re-establishing vegetative cover in disturbed areas

Details for a monitoring program which covers both the Forest View Subdivision and Edgewood Subdivision have been provided previously in the LDS Consolidated Report and Monitoring Program (LDS, July 2023). Recommendations for groundwater and surface water monitoring which are specified in this document should be followed during the construction and post-construction build-out period.

7.3.3 Mitigating Thermal Impacts

Hydrogeological reports for each of the stages of development provide consideration for mitigating thermal impacts to the shallow groundwater and surface water which contribute to base flows to the natural features. Asphalt and other impervious surfaces absorb heat energy and during rainfall events the stored heat is transferred to the runoff. In this regard, SWM designs utilize opportunities to promote infiltration which can help to attenuate temperature changes between warm stormwater run-off conditions, and the cooler groundwater and/or cool surface water conditions within the wooded areas. Green-space and buffer areas adjacent to the wetland provide opportunities for infiltrated surface water (sourced from sheet flow at the site) to travel in the shallow subsurface. Water which naturally infiltrates into the subgrade soils, is expected to match ground temperatures, mimicking the typical range of temperatures which occur in the shallow groundwater under current conditions.

7.3.4 Flooding Events

It is anticipated that flooding associated with frequent storm events (such as the 2- or 5-year storm event) will not yield significant changes to the flooding frequency or duration which would have a significant adverse effect on the wetland features. Small seasonal floods typically contribute a source of nutrients to aquatic ecosystems, and when the nominal increase in the volume of water is assessed over the broad extent of the wetland feature, changes in the flood duration and frequency are not expected to be significant.

For flooding associated with more significant storm events, the volume of flood water which is retained in the wetland may be more likely to have an impact to the ecological features within the wetland areas. The SWM design provides for an overflow outlet which helps to control maximum water levels which can occur within the wooded area, providing an outlet to the south ravine and west Mill Creek Tributary.

7.3.5 Construction Considerations

Fuel Storage, Spills and Equipment Fueling

The use of construction equipment presents a possible risk associated with equipment breakdowns, fuel spills, and fueling of equipment. Recommendations have been provided for establishing a Best Management Practice (BMP) and spill contingency plan (including a spill action response plan) for fuel handling, storage, and onsite equipment maintenance activities to minimize the risk of contaminant releases as a result of the proposed construction activities.

Construction Staging

Designated areas for construction lay-down, vehicle access and parking, equipment storage, and materials stockpiling must be located entirely outside of established designated natural areas and buffers, and preferably not adjacent to the natural features to limit potential impact. Construction equipment must remain within the limits of disturbance at all time.

Site Grading Activities

It is noted that earthworks activities typically require topsoil stripping, temporary stockpiling of soils, and placement of engineered fill and structural fill within proposed lots and roadways. Detailed requirements for erosion and sediment control (ESC) measures throughout the sites and through various stages of construction have been detailed in the design studies. A brief summary of ESC best management practices is provided in Section 5.8.2.

Imported Fill Quality

Importation of fill to the site for the purpose of raising grades would be considered as a beneficial use, and as such, under the On-Site and Excess Soil Management Regulation, O. Reg. 406/19, as amended, the site would be considered a Beneficial Reuse Site. O. Reg 406/19 outlines applicable standards for any fill material which will be brought to site. For the purpose of importing and stockpiling materials at the site, imported materials which are accepted at the site will have concentrations consistent with, or less than the standard concentrations identified in O. Reg. 406/19 Table 1 Full-Depth Background Soil Condition Standards (residential land use) for fill placed within 30 m of the woodlots which contain wetland features, and O.Reg. 406/19 Table 2.1 Excess Soil Condition Standards (ESCS) for residential land-use, for fill placed within the remainder of the site.

As noted previously, LDS will have inspectors onsite providing inspection and testing services, which will include review of any imported soils, and confirm its suitability for use from a geotechnical and hydrogeological standpoint. LDS will also provide a review of soil quality data, to ensure that the above ESCS are satisfied.

8.0 CLOSING

The geotechnical and hydrogeological discussion and recommendations provided in this report are applicable to the project described in the text. LDS would be pleased to provide a review of design drawings and specifications to ensure that the geotechnical comments and recommendations provided in this report have been accurately and appropriately interpreted.

It is important to note that the field work 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 geotechnical recommendations.

The comments given in this report are intended to provide guidance for design engineers. Contractors making use of this report are responsible for their construction methods and practices, and should seek confirmation or additional information if required, to ensure that they understand how subsurface soil and groundwater conditions may affect their work.

No portion of this report may be used as a separate entity. It is intended to be read in its entirety.

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.

LICENSED PROFESSIONAL ENGINEER
Mar 26, 2024
R.A. WALKER
PROVINCE OF ONTARIO

Rebecca A. Walker, P. Eng., QP$_{ESA}$
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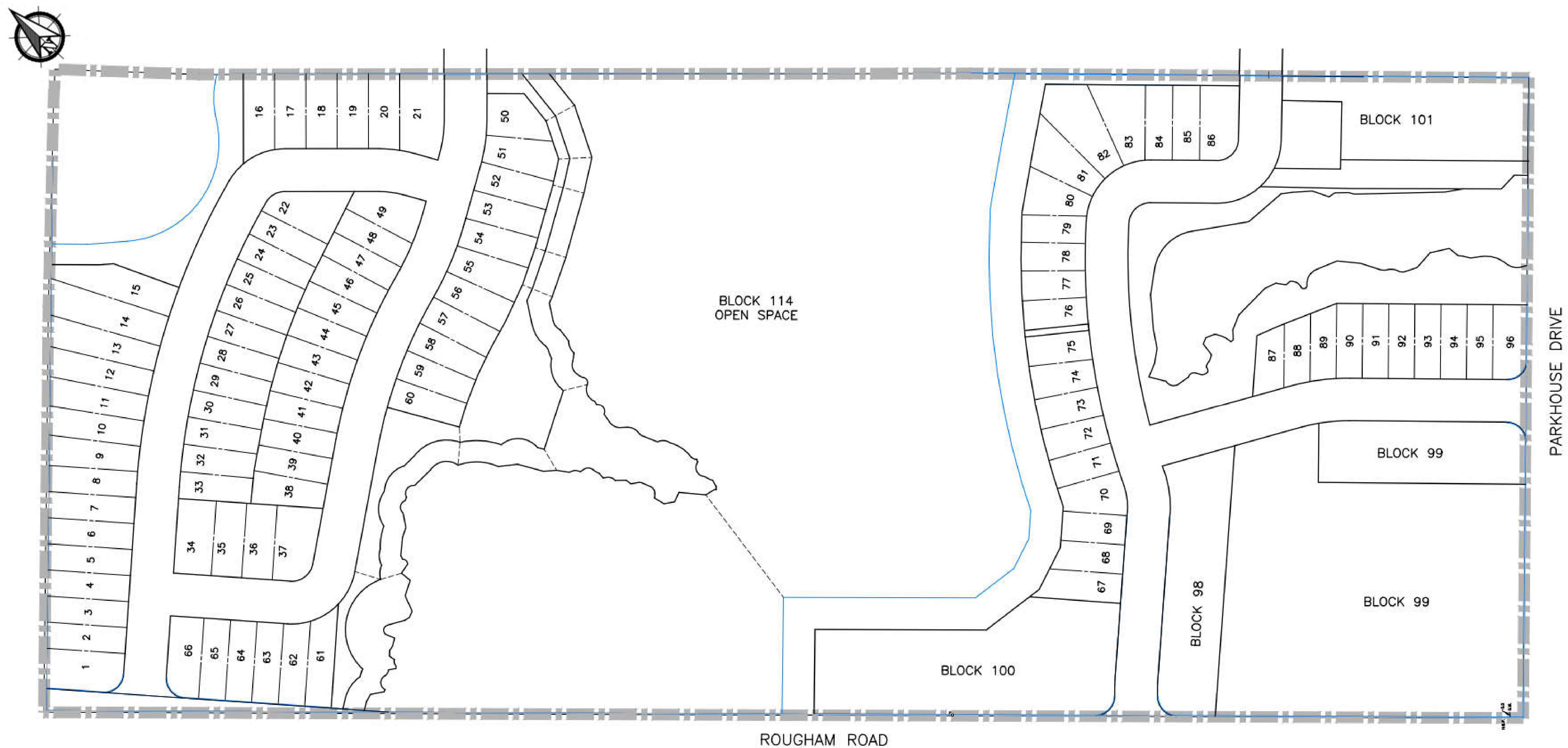
APPENDIX A

DRAWINGS and NOTES



LDS	PROJECT NAME	PROJECT LOCATION	SCALE	PROJECT NO.
	Proposed Residential Subdivision	Rougham Road & Parkhouse Drive Mount Brydges, Ontario	As Shown	GE-00103
	SOURCE:	**FIGURE NAME**	**DATE**	**DRAWING NO.**
	Draft Plan, prepared by LDS Consultants Inc., March 2024.	Concept Plan	March 2024	1

SOURCE
Google Earth Pro, Version 7.3.6.9796,
Imagery Date, March 2024
Coordinates 17T, 459837.03 m E, 4749796.51 m N

LDS

PROJECT NAME
Proposed Residential Subdivision

PROJECT LOCATION
Rougham Road & Parkhouse Drive
Mount Brydges, Ontario

FIGURE NAME
Local Features

SCALE	PROJECT NO.
As Shown	GE-00103
DATE	**DRAWING NO.**
March 2024	**2**

Legend

Significant Groundwater Recharge Area
- N/A
- 0
- 2
- 4
- 6

Issue Contributing Areas

Highly Vulnerable Aquifers

WHPA-E

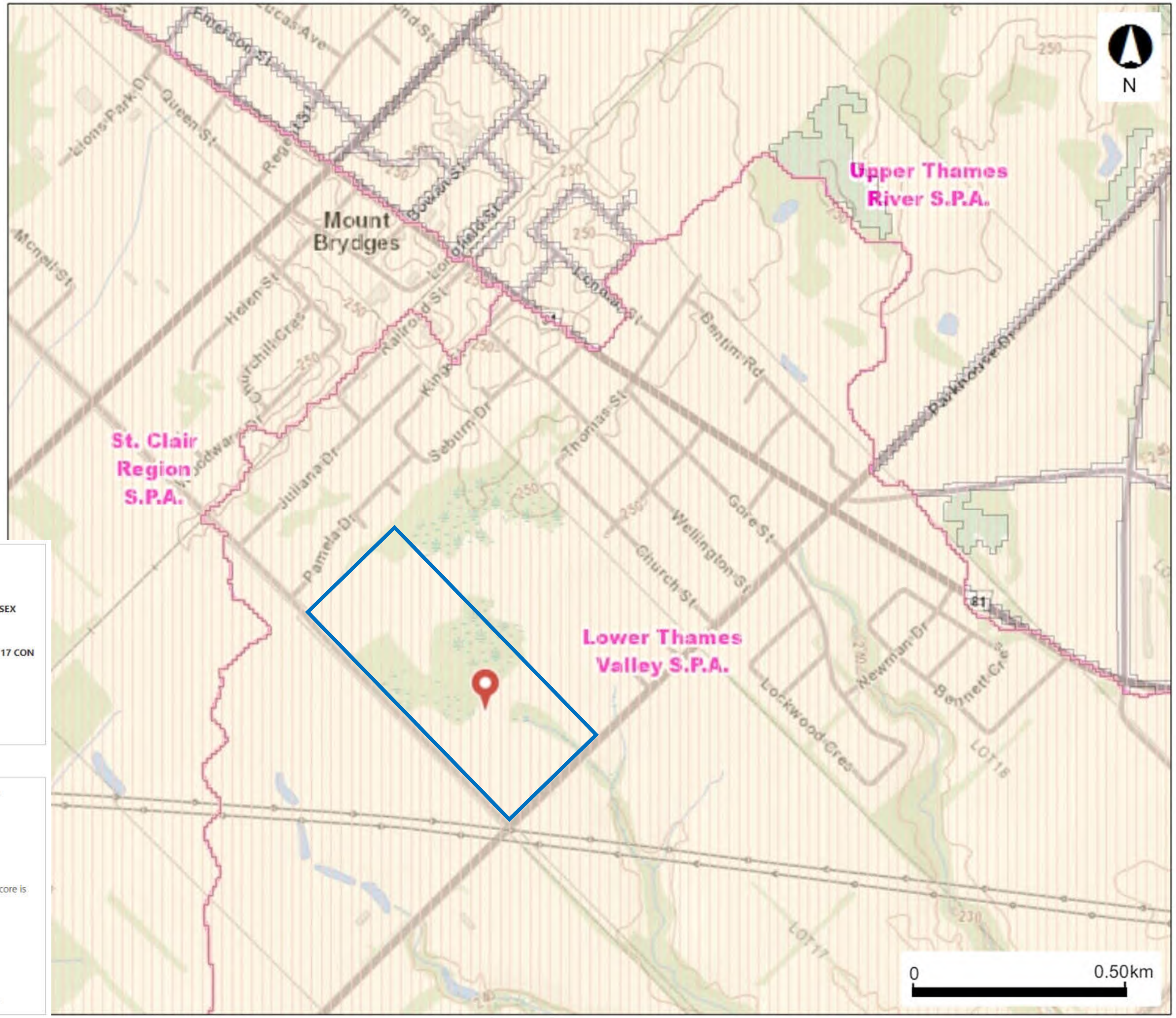
Wellhead Protection Area
- A
- B
- C
- C1
- D
- F

Intake Protection Zone 1

Event Based Areas

Intake Protection Zone 2

Source Protection Areas



Latitude: **42.89811** Longitude: **-81.49136**
UTM Zone: **17**
Easting: **459883.64** Northing: **4749617.62**
Upper Tier Municipality: **COUNTY OF MIDDLESEX**
Lower Tier Municipality: **MUNICIPALITY OF STRATHROY-CARADOC**
Township Concession and Lot: **CARADOC LOT 17 CON 2**
Assessment Parcel Address: **Parkhouse Drive**
Assessment Roll #: **3916014030089000000**
MECP District: **London**
MECP Region: **Southwest Region**

Source Protection Details for Location

Source Protection Area: **Lower Thames Valley**
View Source Protection Plan
Wellhead Protection Area: **No**
Wellhead Protection Area (WHPA-E): **No**
Intake Protection Zone: **No**
Issue Contributing Area: **No**
Significant Groundwater Recharge Area: **Yes** ; score is **N/A**
Highly Vulnerable Aquifer: **Yes** ; score is **6**
Event Based Area: **No**
Wellhead Protection Area Q1: **No**
Wellhead Protection Area Q2: **No**
Intake Protection Zone Q: **No**
Information is current as of: **January 24, 2024**

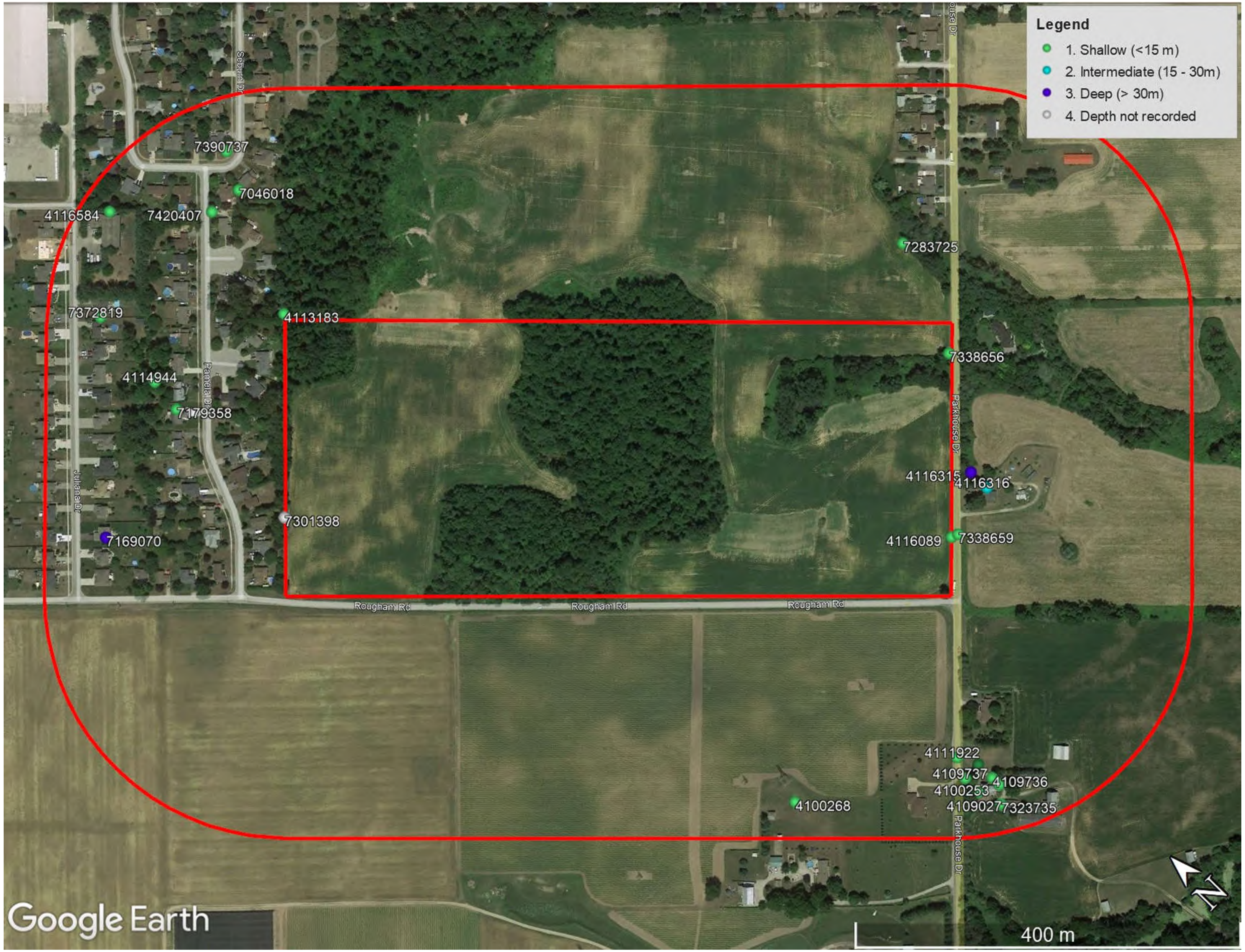
SOURCE
Ministry of Environment, Conservation and Parks
Current to January 24, 2024
/www.ontario.ca/environment-and-energy/map-well-records

PROJECT NAME
Proposed Residential Subdivision

PROJECT LOCATION
Rougham Road & Parkhouse Drive
Mount Brydges, Ontario

FIGURE NAME
Source Water Protection Mapping

SCALE	PROJECT NO.
As Shown	GE-00103
DATE	**DRAWING NO.**
March 2024	3



SOURCE
Ministry of Environment, Conservation and Parks
Current to January 2024 (Google Earth Pro – imagery date, July 2018)
/www.ontario.ca/environment-and-energy/map-well-records

LDS

PROJECT NAME

Proposed Residential Subdivision

PROJECT LOCATION

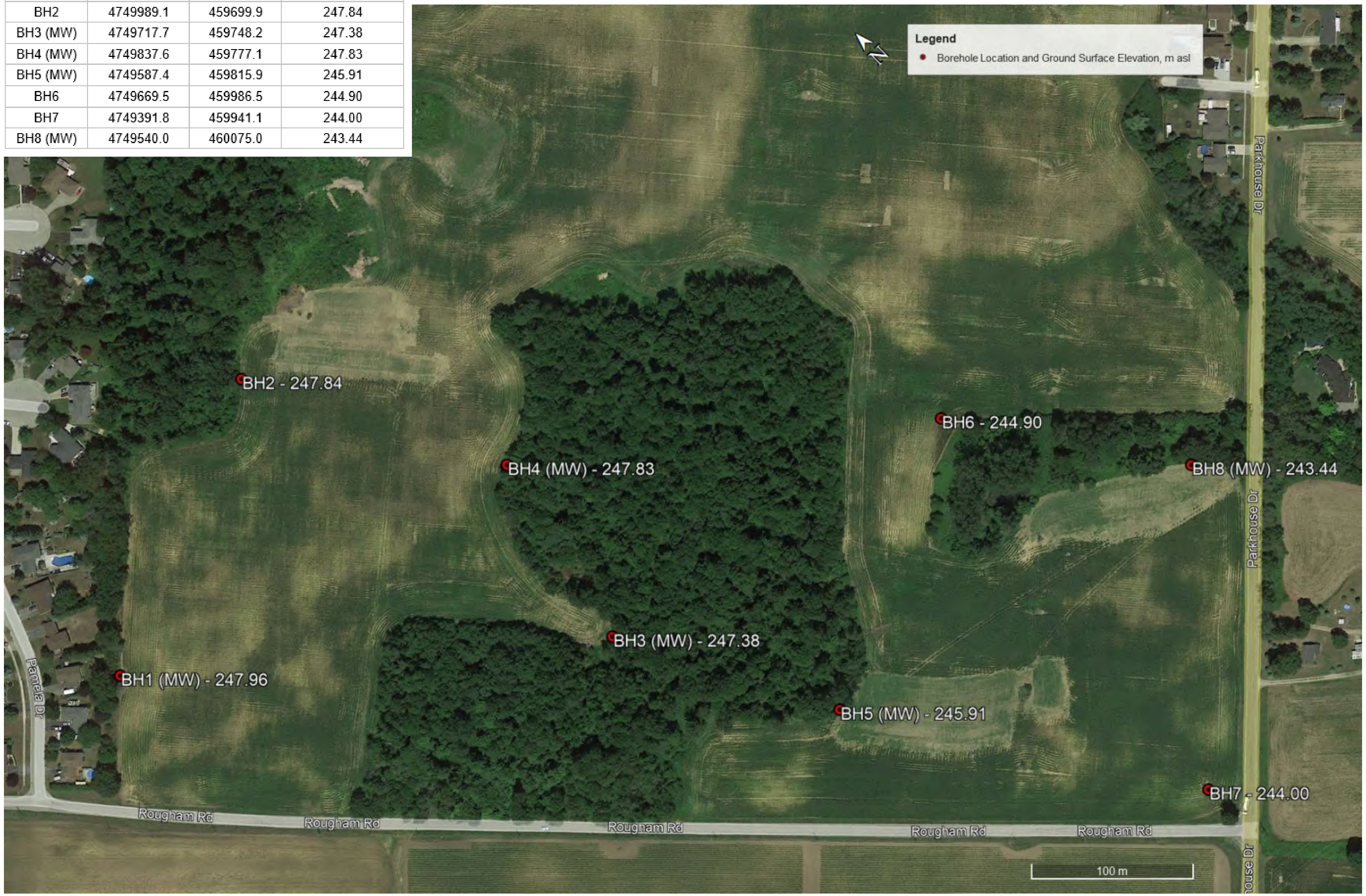
Rougham Road & Parkhouse Drive
Mount Brydges, Ontario

FIGURE NAME

MECP Well Locations

SCALE	PROJECT NO.
As Shown	GE-00103
DATE	**DRAWING NO.**
March 2024	**4**

ID	Northing	Easting	Ground Surface Elevation, m asl
BH1 (MW)	4749913.9	459518.7	247.96
BH2	4749989.1	459699.9	247.84
BH3 (MW)	4749717.7	459748.2	247.38
BH4 (MW)	4749837.6	459777.1	247.83
BH5 (MW)	4749587.4	459815.9	245.91
BH6	4749669.5	459986.5	244.90
BH7	4749391.8	459941.1	244.00
BH8 (MW)	4749540.0	460075.0	243.44



SOURCE
Google Earth Pro. Version 7.3.6.9796
17T 459480 m N, 4749809 m E
Image Date 07/02/2018

Borehole locations surveyed by LDS

LDS

PROJECT NAME

Proposed Residential Subdivision

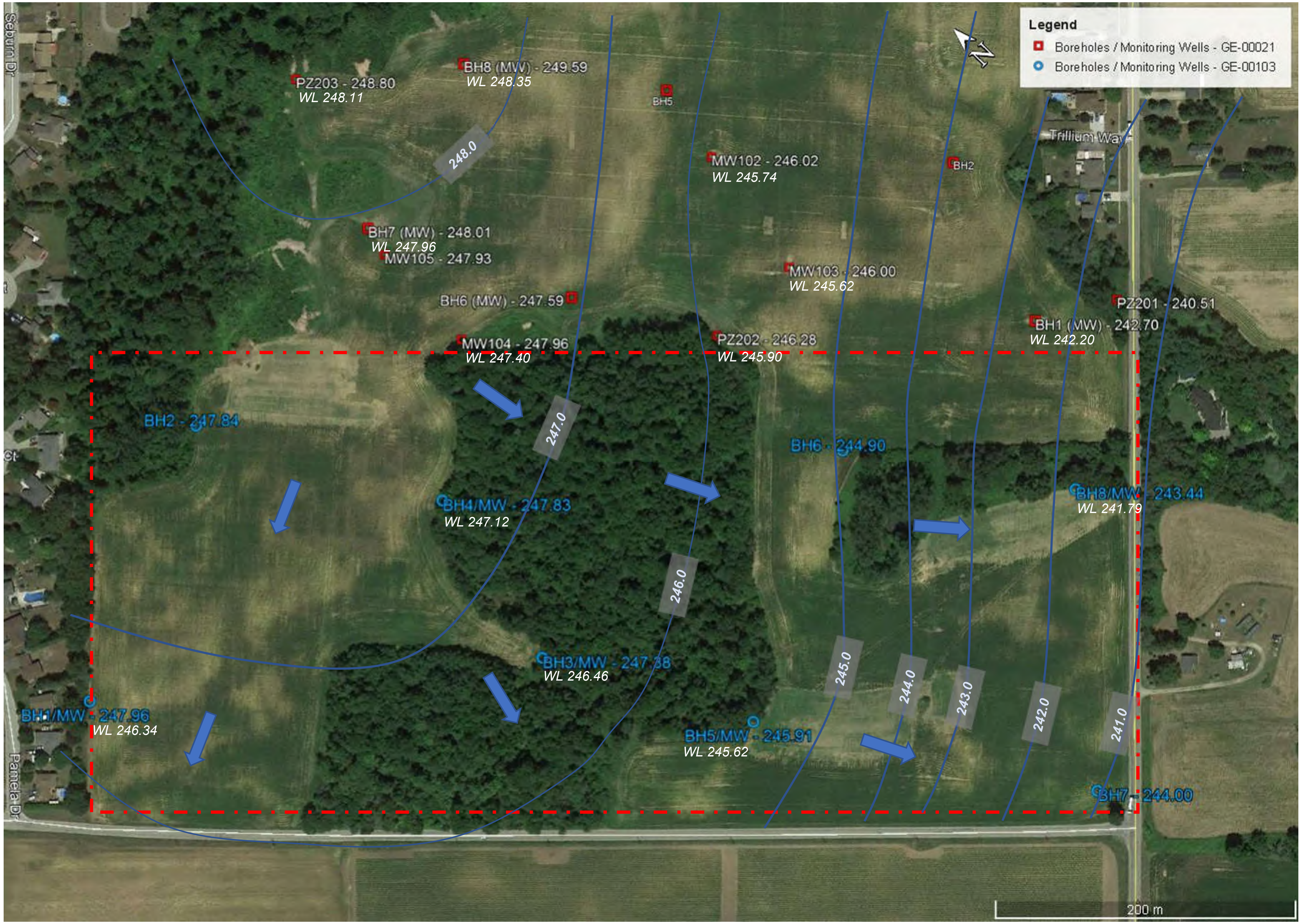
PROJECT LOCATION

Rougham Road & Parkhouse Drive
Mount Brydges, Ontario

FIGURE NAME

Borehole Location Plan

SCALE	PROJECT NO.
As Shown	GE-00103
DATE	**DRAWING NO.**
March 2024	**5**



SOURCE:
Google Earth Pro. Version 7.3.6.9796
17T 459480 m N, 4749809 m E
Image Date 07/02/2018

Borehole locations surveyed by LDS.
Borehole and groundwater data included from GE-00021, Edgewood Subdivision groundwater monitoring program for lands to the east.

Water Levels taken April 18, 2018

Ground surface elevations and water level elevations are in m, ASL

LDS

PROJECT NAME

Proposed Residential Subdivision

PROJECT LOCATION

Rougham Road & Parkhouse Drive
Mount Brydges, Ontario

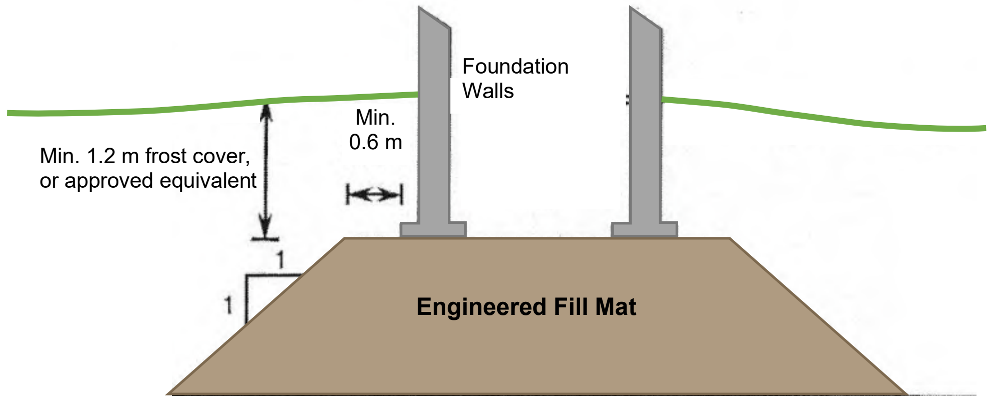
FIGURE NAME

Groundwater Contours
(Spring 2018)

SCALE	PROJECT NO.
As Shown	GE-00103
DATE	**DRAWING NO.**
March 2024	**6**

ENGINEERED FILL PLACEMENT

SCHEMATIC DIAGRAM



NOTES:

1. The area must be stripped of all topsoil contaminated fill material, and other unsuitable soils, and proof rolled. Soft spots must be dug out. The stripped natural subgrade must be examined and approved by the geotechnical consultant**.**

2. In areas where engineered fill is placed on a slope, the fill should be benched into the approved subgrade soils.

3. Material used for engineered fill must be free of topsoil, organics, frost and frozen material, and otherwise unsuitable or compressible soils, as determined by a Geotechnical Engineer. Any material proposed for use as engineered fill must be examined and approved prior to use onsite.

4. Engineered fill should be placed in maximum 300 mm thick lifts, and uniformly compacted to 100% Standard Proctor dry density. For best compaction results, engineered fill should be within 3 percent of its optimum moisture content, as determined by the Standard Proctor density test.

5. Full time geotechnical monitoring, inspection and in-situ density (compaction) is required during placement of the engineered fill.

6. Site grades should be maintained during area grading activities to promote drainage, and to minimize ponding of surface water on the engineered fill mat. Rutting by construction equipment should be kept to a minimum, where possible. Additional work to ensure suitability of engineered fill may be required if fill is placed in inclement weather conditions.

7. The fill must be placed such that the specified geometry is achieved. Refer to schematic diagram for minimum requirements. Environmental protection may be required, such as frost protection during construction, and after the completion of the engineered fill mat.

8. An allowable bearing pressure of 175 kPa (3650 psf) may be used provided that all conditions outlined above, and in the Geotechnical Report are adhered to.

These guidelines are to be read in conjunction with the attached Geotechnical Report prepared by LDS Consultants Inc.

LDS	PROJECT NAME Proposed Residential Subdivision	PROJECT NO. GE-00103
	PROJECT LOCATION Rougham Road, Mount Brydges	DRAWING NO. 7

APPENDIX B

BOREHOLE LOGS & LABORATORY TEST RESULTS

NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the Canadian Foundation Engineering Manual (CFEM) 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 CFEM 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 CFEM 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			Borehole ID
	Project	**Proposed Residential Subdivision**	**1/MW**
	Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**	*Sheet 1 of 1*
	Project Number	**GE-00103**	

Date Drilled	**30-Oct-17**	Ground Surface Elevation	**247.96 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**2.77 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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, 75 mm	
0.5						**SAND** - brown, fine grained, loose, moist	
1.0	SPT	1	70	6			MC 4.0%
1.5–2.0	SPT	2	70	8			
2.5	SPT	3	60	9	▽	- stratified and saturated below 2.5 m bgs	
3.0–3.5	SPT	4	60	12		- becoming compact below 3.0 m bgs	MC 25.1%
4.0							
4.5–5.0	SPT	5	80	18			
5.5							
6.0–6.5	SPT	6	70	5	6.55m	*Gradation - SA6* *0.0% Gravel, 87.6% Sand, 12.4% Silt*	MC 22.1%
6.55						BH Terminated at 6.55 m depth Open, with water measured at 2.77 m upon completion	
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	**6.10 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 - 2.4 m**

Additional Notes

MC - denotes moisture content

Project	**Proposed Residential Subdivision**		Borehole ID
Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**		**2**
Project Number	**GE-00103**		*Sheet 1 of 1*

Date Drilled	**30-Oct-17**	Ground Surface Elevation	**247.84 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**3.65 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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
						TOPSOIL - brown, sandy loam, 75 mm	
0.5						**SAND** - brown, fine grained, compact, moist	
1.0	SPT	1	60	13			
1.5							
2.0	SPT	2	60	18			MC 25.6%
2.5	SPT	3	60	12		- saturated below 2.4 m bgs	
3.0					3.10 m	**SANDY SILT** - grey, stiff, saturated	
3.5	SPT	4	70	9	Inferred Groundwater	*Gradation - SA4* *0.0% Gravel, 16.0% Sand, 81.9% Silt, 2.1% Clay*	MC 23.2%
4.0							
4.5							
5.0	SPT	5	100	8			MC 24.2%
5.5							
6.0						- firm below 6.1 m bgs	
6.5	SPT	6	70	2	6.55m	BH Terminated at 6.55 m depth Open, with water measured at 3.65 m upon completion	
7.0							
7.5							
8.0							

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

Well Construction Details

Pipe Diameter	--
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC - denotes moisture content

Project	Proposed Residential Subdivision	Borehole ID
Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**	**3/MW**
Project Number	**GE-00103**	*Sheet 1 of 1*

Date Drilled	**30-Oct-17**	Ground Surface Elevation	**247.38 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**3.37 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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
						TOPSOIL - brown, sandy loam, 75 mm	
0.5						**SAND** - brown, fine grained, loose, moist	
1.0	SPT	1	60	7			
1.5						- becoming compact below 1.5 m bgs	
2.0	SPT	2	70	16	2.15m		
2.5	SPT	3	50	19		**SILT** - brown to grey, trace sand, trace gravel, firm to stiff, saturated	MC 21.3%
3.0	SPT	4	60	21	▽	*Gradation - SA4* *0.0% Gravel, 2.8% Sand, 95.0% Silt, 2.2% Clay*	
3.5							
4.0							MC 24.3%
4.5	SPT	5	60	11			
5.0							
5.5						- trace to some clay below 5.5 m bgs	
6.0	SPT	6	70	9	6.55m		MC 31.2%
6.5						BH Terminated at 6.55 m depth Open, with water measured at 3.37 m upon completion	
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	**6.10 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 - 2.4 m**

Additional Notes

MC - denotes moisture content

Project	Proposed Residential Subdivision	Borehole ID
Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**	**4/MW**
Project Number	**GE-00103**	*Sheet 1 of 1*

Date Drilled	**30-Oct-17**	Ground Surface Elevation	**247.83 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**3.22 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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
						TOPSOIL - brown, sandy loam, 75 mm	
0.5						**SAND** - brown, fine grained, compact, moist	
1.0	SPT	1	70	13			MC 4.6%
1.5	SPT	2	70	18			
2.0							
2.5	SPT	3	60	12	2.65m	- saturated and loose below 2.4 m bgs	MC 24.3%
3.0	SPT	4	60	9	Inferred Groundwater	**SANDY SILT** - brown to grey, trace gravel, loose,	
3.5							
4.0							
4.5	SPT	5	80	8		*Gradation - SA5* *0.0% Gravel, 21.4% Sand, 77.5% Silt, 1.1% Clay*	
5.0							
5.5							
6.0	SPT	6	80	2	6.55m		MC 31.2%
6.5						BH Terminated at 6.55 m depth Open, with water measured at 3.22 m upon completion	
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	**6.10 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 - 2.4 m**

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Residential Subdivision**	Borehole ID
	Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**	**5**
	Project Number	**GE-00103**	*Sheet 1 of 1*

Date Drilled	**3-Nov-17**	Ground Surface Elevation	**247.83 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**2.82 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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
						TOPSOIL - brown, sandy loam, 75 mm	
0.5						**SAND** - brown, fine grained, loose, moist	
1.0	SPT	1	60	6			
1.5	SPT	2	60	10		- very moist to wet below 1.5 m bgs	
2.0					*2.20m*		MC 21.7%
2.5	SPT	3	60	12	Inferred Groundwater	**SANDY SILT** - brown to grey, trace gravel, compact,	
3.0	SPT	4	60	10			
3.5							
4.0						*Gradation - SA4* *0.0% Gravel, 16.8% Sand, 80.7% Silt, 2.5% Clay*	MC 20.3%
4.5	SPT	5	70	11			
5.0							
5.5							
6.0	SPT	6	90	9	*6.55m*	*Gradation - SA6* *0.0% Gravel, 16.0% Sand, 81.9% Silt, 2.1% Clay*	MC 21.8%
6.5						BH Terminated at 6.55 m depth Open, with water measured at 2.82 m upon completion	
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	**6.09 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 - 2.4 m**

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Residential Subdivision**	Borehole ID
	Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**	**6**
	Project Number	**GE-00103**	*Sheet 1 of 1*

Date Drilled	**30-Oct-17**	Ground Surface Elevation	**247.83 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**4.26 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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
						TOPSOIL - brown, sandy loam, 75 mm	
0.5						**SAND** - brown, fine grained, compact, moist	
1.0	SPT	1	70	13			
1.5–2.0	SPT	2	70	18			MC 21.6%
2.5	SPT	3	60	12		- saturated and loose below 2.4 m bgs	MC 29.4%
3.0–3.5	SPT	4	60	9			
4.0–4.5					Inferred groundwater		
4.5–5.0	SPT	5	80	8		- trace silt to silty below 4.5 m bgs	
5.5							
6.0–6.5	SPT	6	80	2	6.25m / 6.55m	**SANDY SILT** - grey, trace to some clay, firm, wet	MC 26.3%
6.55						BH Terminated at 6.55 m depth Open, with water measured at 4.26 m upon completion	
7.0							
7.5							
8.0							

Legend

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

Well Construction Details

Pipe Diameter	--
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC - denotes moisture content

	Project	Proposed Residential Subdivision	Borehole ID
LDS	Project Location	Rougham Road and Parkhouse Drive, Mt. Brydges	7
	Project Number	GE-00103	Sheet 1 of 1

Date Drilled	**3-Nov-17**	Ground Surface Elevation	**247.83 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**5.47 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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
						TOPSOIL - brown, sandy loam, 150 mm	
0.5						**SAND** - brown, fine grained, trace to some silt, loose,	
1.0	SPT	1	50	8			
1.5						- compact below 1.5 m depth	
2.0	SPT	2	50	14			MC 23.7%
2.5	SPT	3	60	14		- silty, saturated and loose below 2.4 m bgs	
3.0	SPT	4	60	19		*Gradation - SA4* *0.0% Gravel, 69.1% Sand, 30.9% Silt*	
3.5							
4.0					4.00m	**SANDY SILT** - brown to grey, trace gravel, firm to stiff,	
4.5							
5.0	SPT	5	70	7			MC 23.0%
5.5					Inferred Groundwater		
6.0							
6.5	SPT	6	80	10	6.55m		MC 26.3%
7.0						BH Terminated at 6.55 m depth Open, with water measured at 5.47 m upon completion	
7.5							
8.0							

Legend

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

Well Construction Details

Pipe Diameter	--
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC - denotes moisture content

Project	**Proposed Residential Subdivision**	Borehole ID	**8**
Project Location	**Rougham Road and Parkhouse Drive, Mt. Brydges**		
Project Number	**GE-00103**		*Sheet 1 of 1*

Date Drilled	**3-Nov-17**	Ground Surface Elevation	**243.43 m**
Drill Rig	**D50 - Turbo**	Groundwater Level at Completion	**2.85 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Rob 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 – 0.15						**TOPSOIL** - brown, sandy loam, 150 mm	
0.5						**SAND** - brown, fine grained, loose, moist	
1.0	SPT	1	50	8		- brown sandy silt layer (less than 1 m thick), loose, moist *Gradation - SA1* *0.0% Gravel, 25.5% Sand, 69.5% Silt, 5.0% Clay*	MC 9.5%
1.5 – 2.0	SPT	2	50	14			
2.5	SPT	3	60	14		- stratified and saturated below 2.4 m bgs	
3.0 – 3.5	SPT	4	60	19	Inferred groundwater		MC 25.4%
4.0					*4.05m*		
4.5 – 5.0	SPT	5	70	7		**SANDY SILT** - brown to grey, trace gravel, firm to stiff, saturated	
6.0 – 6.5	SPT	6	80	10	*6.55m*		MC 23.7%
7.0 – 8.0						BH Terminated at 6.55 m depth Open, with water measured at 2.85 m upon completion	

Legend

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

Well Construction Details

Pipe Diameter	**50 mm**
Installation Depth	**6.09 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 - 2.4 m**

Additional Notes

MC - denotes moisture content

Particle Size Distribution
Results of Sieve Analysis

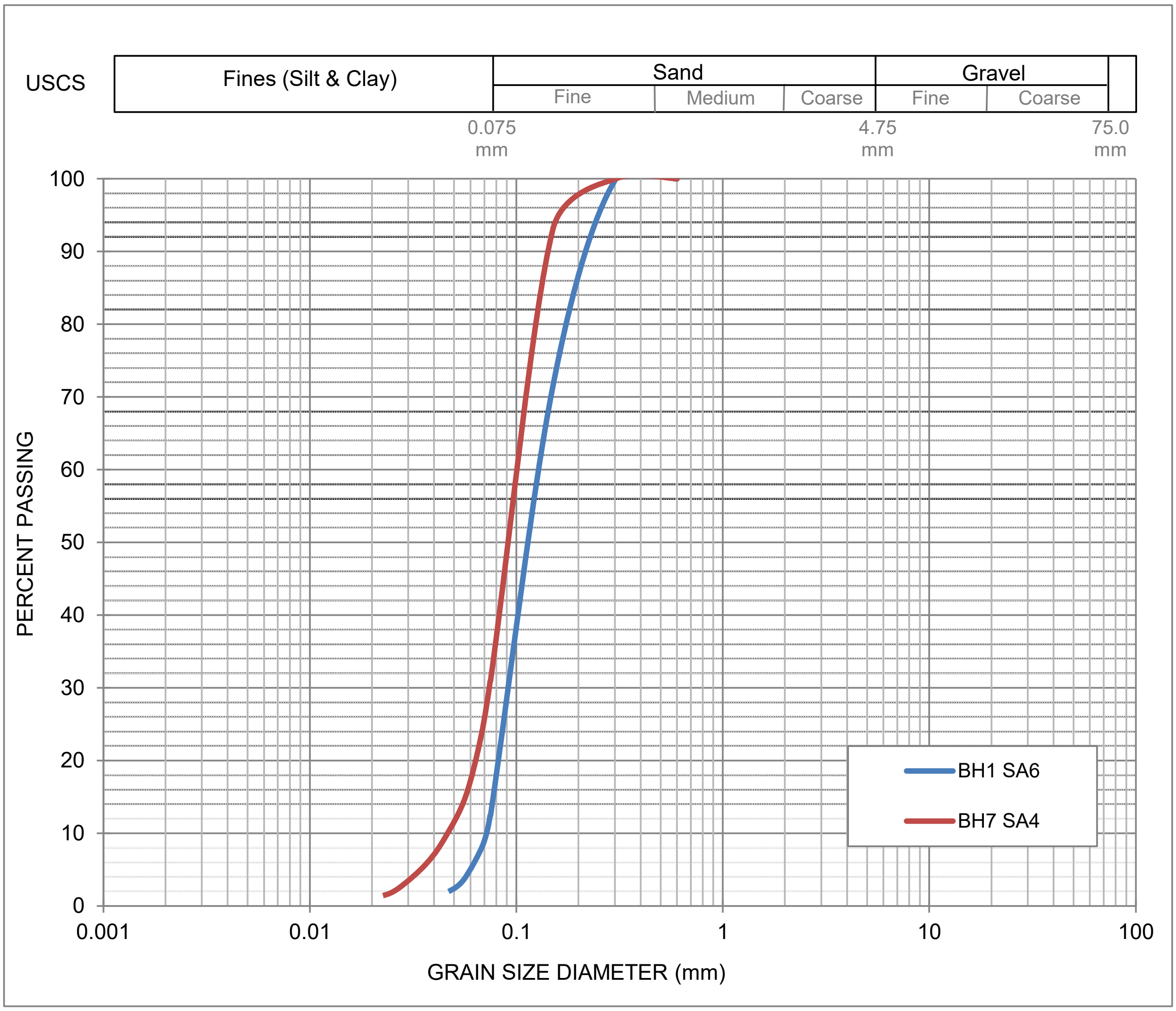
Project Name: Proposed Residential Subdivision Development
Sifton Properties Limited

Date: Dec 10 2019

Project Location: Rougham Road & Parkhouse Drive, Mt Brydges

Project No.: GE-00103

Sample ID	Unified Soil Classification				Moisture Content
	% Clay	% Silt	% Sand	% Gravel	
BH1 SA6	0.0%	12.4%	87.6%	0.0%	22.1%
BH7 SA4	0.0%	30.9%	69.1%	0.0%	23.0%



Particle Size Distribution
Results of Sieve Analysis

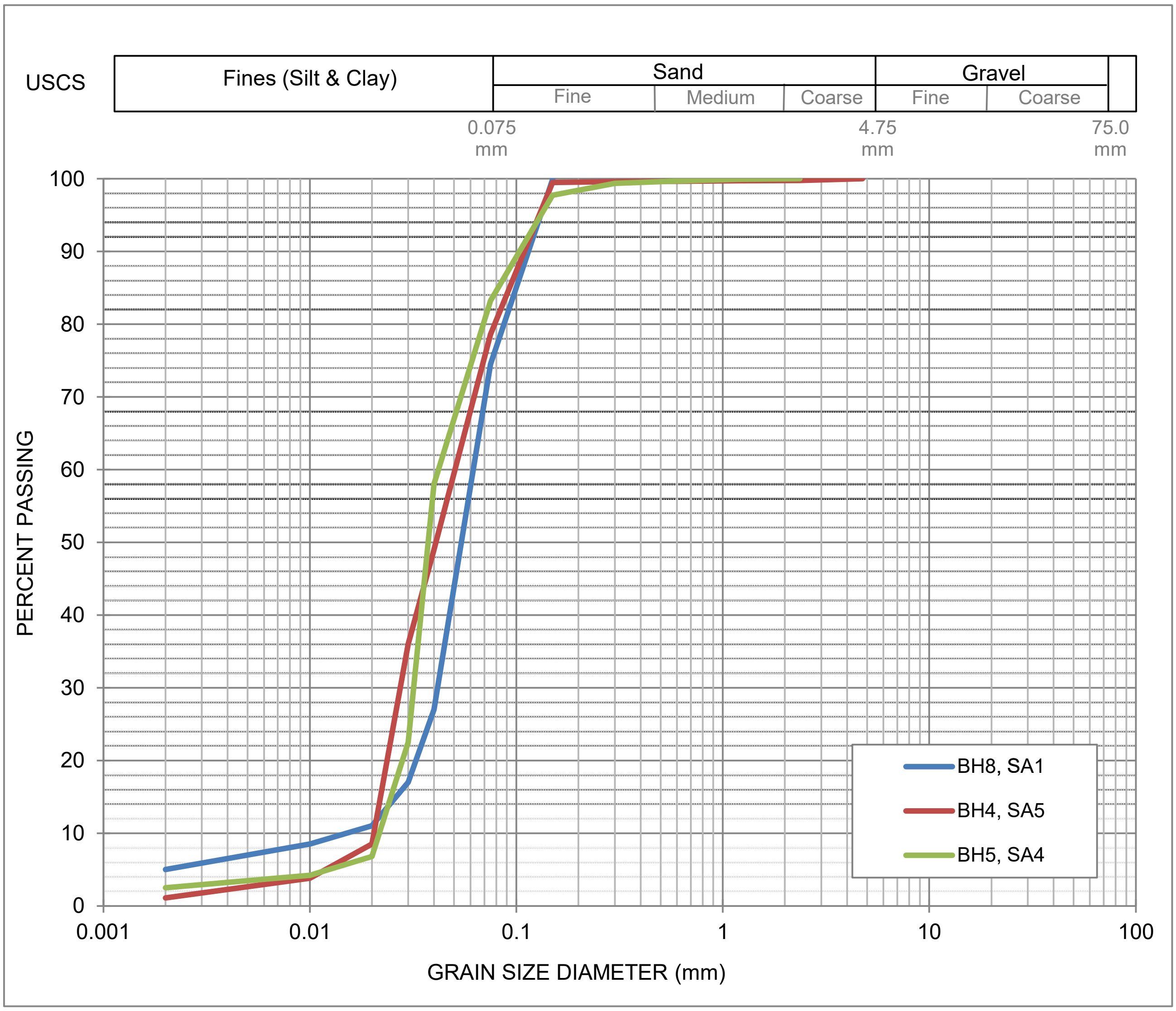
Project Name: Proposed Residential Subdivision Development
Sifton Properties Limited

Date: Dec 10 2019

Project Location: Rougham Road & Parkhouse Drive, Mt Brydges

Project No.: GE-00103

Sample ID	Unified Soil Classification				Moisture Content
	% Clay	% Silt	% Sand	% Gravel	
BH8, SA1	5.0%	69.5%	25.5%	0.0%	9.5%
BH4, SA5	1.1%	77.5%	21.4%	0.0%	N/R
BH5, SA4	2.5%	80.7%	16.8%	0.0%	20.3%



Particle Size Distribution
Results of Sieve Analysis

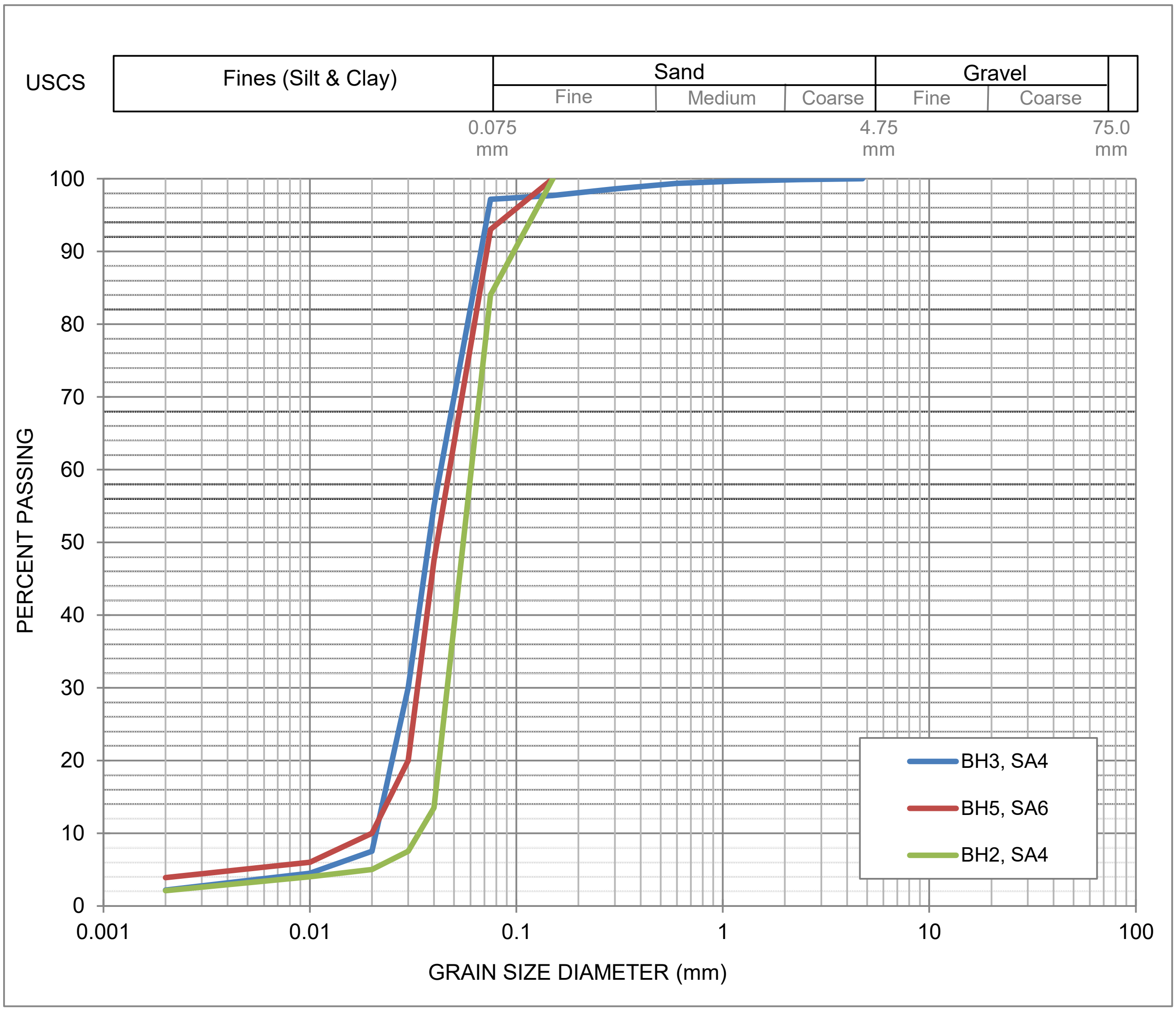
Project Name: Proposed Residential Subdivision Development
Sifton Properties Limited

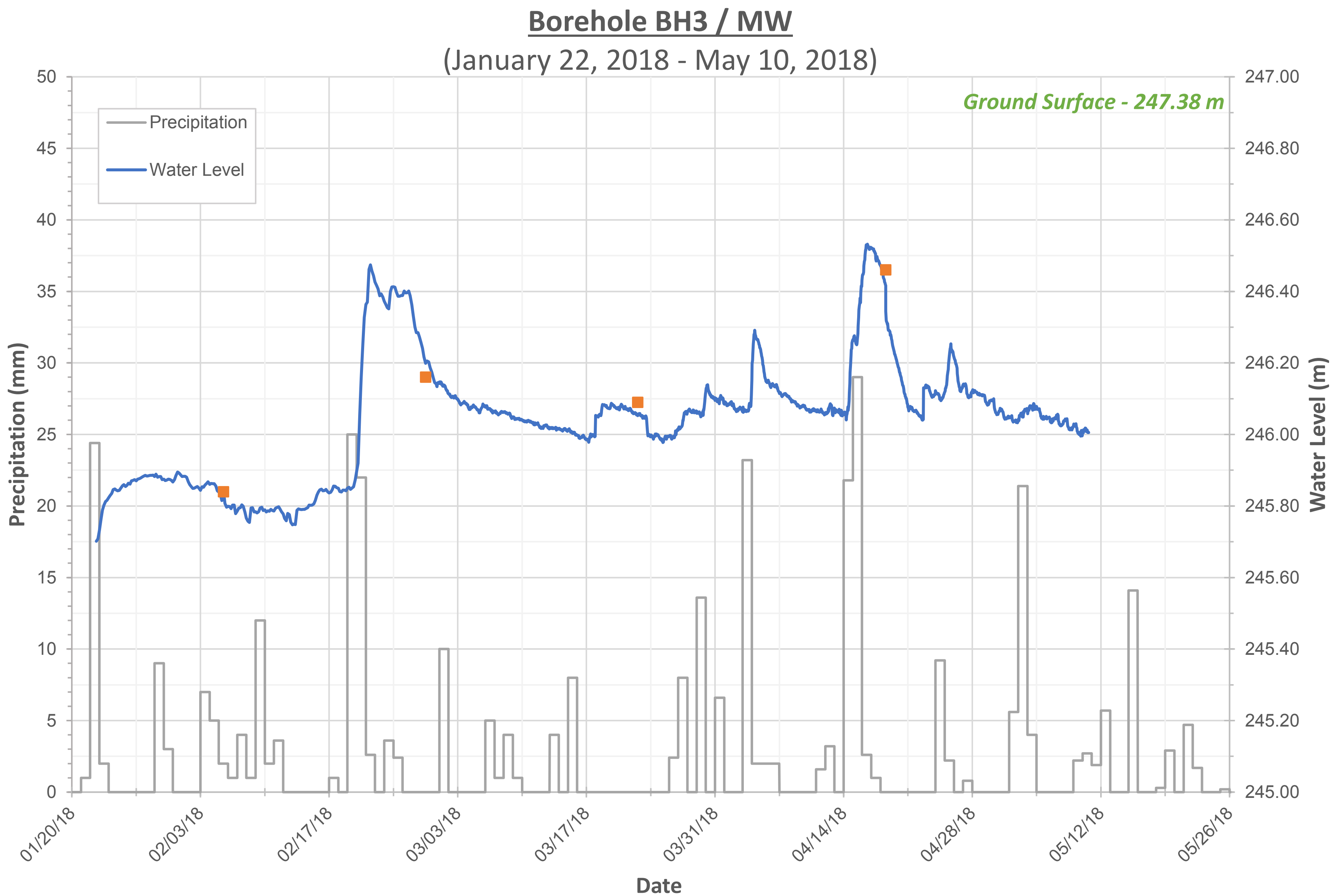
Date: Dec 10 2019

Project Location: Rougham Road & Parkhouse Drive, Mt Brydges

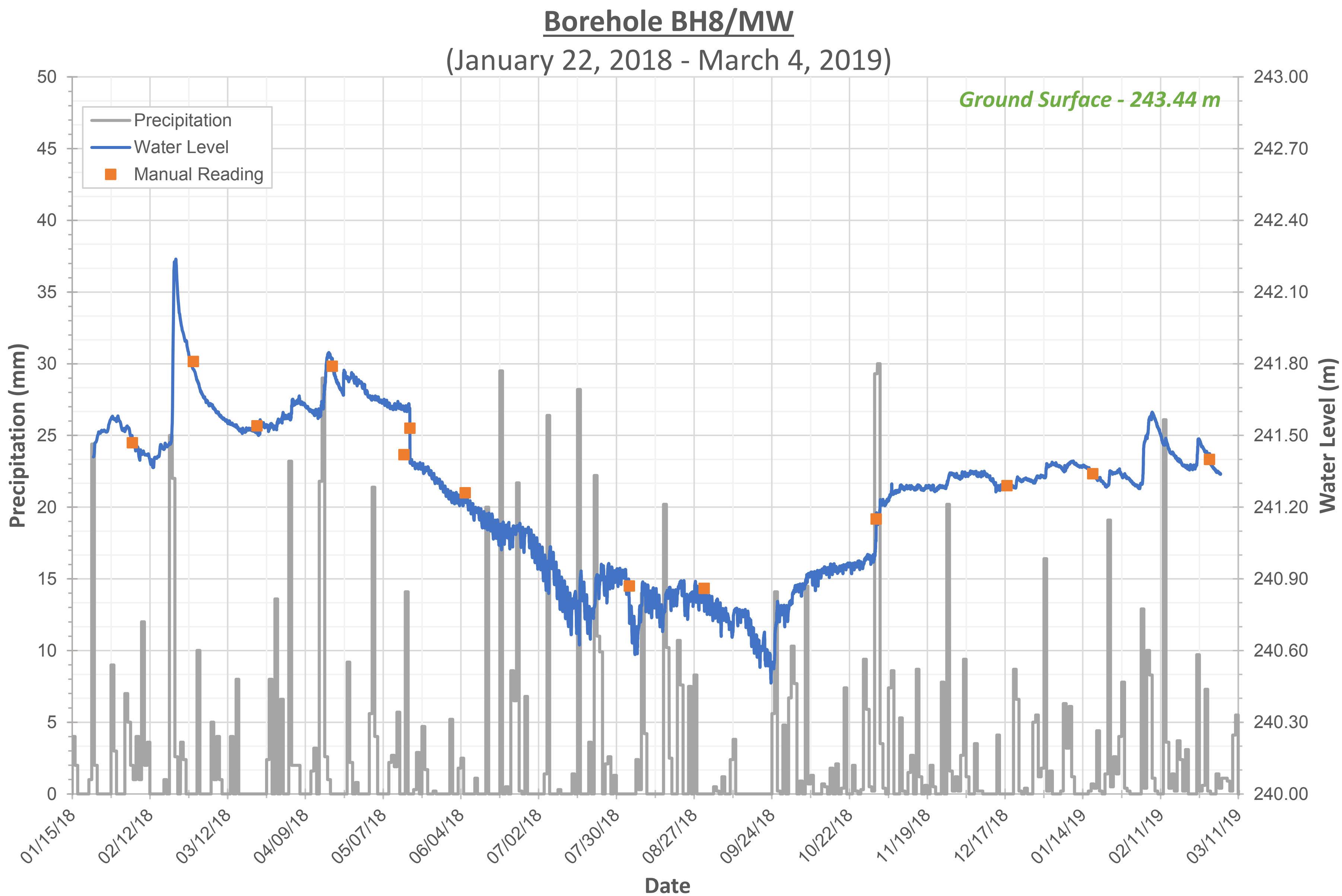
Project No.: GE-00103

Sample ID	Unified Soil Classification				Moisture Content
	% Clay	% Silt	% Sand	% Gravel	
BH3, SA4	2.2%	95.0%	2.8%	0.0%	24.3%
BH5, SA6	3.9%	89.1%	7.0%	0.0%	21.8%
BH2, SA4	2.1%	81.9%	16.0%	0.0%	23.2%





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



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

APPENDIX C

GROUNDWATER QUALITY – LABORATORY CERTIFICATES

Site Location	Forestview Subdivision (Vansevenant Property), Mt Brydges
LDS Project Reference	GE-00103
Water Sample Collection Date	2018-12-21
Sample Location	BH3
Technician	Rob Walker
Analytical Laboratory	Maxxam Analytics
Maxxam Job No.	B8X8971
Certificate of Analyses	Report #: R8836370

Maxxam ID			**IOX374**
COC Number			**695985-01-01**
Parameter	**UNITS**	**ODWS**	**BH3**
Calculated Parameters			
Anion Sum	me/L		5.66
Bicarb. Alkalinity (calc. as CaCO3)	mg/L		190
Calculated TDS	mg/L		310
Carb. Alkalinity (calc. as CaCO3)	mg/L		1.70
Cation Sum	me/L		5.52
Hardness (CaCO3)	mg/L		270
Ion Balance (% Difference)	%		1.27
Langelier Index (@ 20C)	N/A		0.71
Langelier Index (@ 4C)	N/A		0.46
Saturation pH (@ 20C)	N/A		7.25
Saturation pH (@ 4C)	N/A		7.50

Inorganics			
Total Ammonia-N	mg/L		<0.050
Conductivity	umho/cm		520
Dissolved Organic Carbon	mg/L		1.90
Orthophosphate (P)	mg/L		<0.010
pH	pH		7.96
Dissolved Sulphate (SO4)	mg/L	*500 mg/L*	72
Alkalinity (Total as CaCO3)	mg/L		190
Dissolved Chloride (Cl-)	mg/L	*250 mg/L*	9.10
Nitrite (N)	mg/L	1 mg/L	<0.010
Nitrate (N)	mg/L	10 mg/L	0.22
Nitrate + Nitrite (N)	mg/L		0.22

Maxxam ID			**IOX374**
COC Number			**695985-01-01**
Parameter	**UNITS**	**ODWS**	**BH3**
Metals			
Dissolved Aluminum (Al)	ug/L	*0.1 mg/L (100 ug/L)*	<5.0
Dissolved Antimony (Sb)	ug/L	0.006 mg/L (6 ug/L)	<0.50
Dissolved Arsenic (As)	ug/L	0.01 mg/L (10 ug/L)	<1.0
Dissolved Barium (Ba)	ug/L	1 mg/L (1000 ug/L)	18
Dissolved Beryllium (Be)	ug/L		<0.50
Dissolved Boron (B)	ug/L	5 mg/L (5000 ug/L)	15
Dissolved Cadmium (Cd)	ug/L	0.005 mg/L (5 ug/L)	<0.10
Dissolved Calcium (Ca)	ug/L		77000
Dissolved Chromium (Cr)	ug/L	0.05 mg/L (50 ug/L)	<5.0
Dissolved Cobalt (Co)	ug/L		<0.50
Dissolved Copper (Cu)	ug/L	*1 mg/L (1000 ug/L)*	3.9
Dissolved Iron (Fe)	ug/L	*0.3 mg/L (300 ug/L)*	<100
Dissolved Lead (Pb)	ug/L	0.01 mg/L (10 ug/L)	<0.50
Dissolved Magnesium (Mg)	ug/L		19000
Dissolved Manganese (Mn)	ug/L	*0.05 mg/L (50 ug/L)*	4.4
Dissolved Molybdenum (Mo)	ug/L		0.96
Dissolved Nickel (Ni)	ug/L		<1.0
Dissolved Phosphorus (P)	ug/L		<100
Dissolved Potassium (K)	ug/L		680
Dissolved Selenium (Se)	ug/L	0.05 mg/L (50 ug/L)	<2.0
Dissolved Silicon (Si)	ug/L		4900
Dissolved Silver (Ag)	ug/L		<0.10
Dissolved Sodium (Na)	ug/L	20 mg/L (20000 ug/L)	2500
	ug/L	*200 mg/L (200000 ug/L)*	2500
Dissolved Strontium (Sr)	ug/L		130
Dissolved Thallium (Tl)	ug/L		<0.050
Dissolved Titanium (Ti)	ug/L		<5.0
Dissolved Uranium (U)	ug/L	0.02 mg/L (20 ug/L)	0.98
Dissolved Vanadium (V)	ug/L		<0.50
Dissolved Zinc (Zn)	ug/L	*5 mg/L (5000 ug/L)*	<5

Notes:
ODWS - Denotes Ontario Drinking Water Standards
black font - maximum allowable concentrations
blue italics - aesthetic objectives

Results denote exceedance on Max. Allowable Conc.
Results denote exceedance on aesthetic objectives.

Results Reviewed By:

R. Walker

Rebecca Walker, P.Eng.
LDS CONSULTANTS INC.

Site Location	Forestview Subdivision (Vansevenant Property), Mt Brydges
LDS Project Reference	GE-00103
Water Sample Collection Date	2018-12-21
Sample Location	BH8
Technician	Rob Walker
Analytical Laboratory	Maxxam Analytics
Maxxam Job No.	B8X8971
Certificate of Analyses	Report #: R8836370

Maxxam ID			**IOX375**
COC Number			**695985-01-01**
Parameter	**UNITS**	**ODWS**	**BH8**
Calculated Parameters			
Anion Sum	me/L		6.37
Bicarb. Alkalinity (calc. as CaCO3)	mg/L		230
Calculated TDS	mg/L		360
Carb. Alkalinity (calc. as CaCO3)	mg/L		1.60
Cation Sum	me/L		6.05
Hardness (CaCO3)	mg/L		300
Ion Balance (% Difference)	%		2.59
Langelier Index (@ 20C)	N/A		7.555
Langelier Index (@ 4C)	N/A		0.506
Saturation pH (@ 20C)	N/A		7.12
Saturation pH (@ 4C)	N/A		7.37

Inorganics			
Total Ammonia-N	mg/L		<0.050
Conductivity	umho/cm		600
Dissolved Organic Carbon	mg/L		<0.50
Orthophosphate (P)	mg/L		<0.010
pH	pH		7.87
Dissolved Sulphate (SO4)	mg/L	*500 mg/L*	3.1
Alkalinity (Total as CaCO3)	mg/L		230
Dissolved Chloride (Cl-)	mg/L	*250 mg/L*	12.00
Nitrite (N)	mg/L	1 mg/L	<0.010
Nitrate (N)	mg/L	10 mg/L	18.4
Nitrate + Nitrite (N)	mg/L		18.4

Maxxam ID			**IOX375**
COC Number			**695985-01-01**
Parameter	**UNITS**	**ODWS**	**BH8**
Metals			
Dissolved Aluminum (Al)	ug/L	*0.1 mg/L (100 ug/L)*	<5.0
Dissolved Antimony (Sb)	ug/L	0.006 mg/L (6 ug/L)	<0.50
Dissolved Arsenic (As)	ug/L	0.01 mg/L (10 ug/L)	<1.0
Dissolved Barium (Ba)	ug/L	1 mg/L (1000 ug/L)	7.1
Dissolved Beryllium (Be)	ug/L		<0.50
Dissolved Boron (B)	ug/L	5 mg/L (5000 ug/L)	<10
Dissolved Cadmium (Cd)	ug/L	0.005 mg/L (5 ug/L)	<0.10
Dissolved Calcium (Ca)	ug/L		89000
Dissolved Chromium (Cr)	ug/L	0.05 mg/L (50 ug/L)	<5.0
Dissolved Cobalt (Co)	ug/L		<0.50
Dissolved Copper (Cu)	ug/L	*1 mg/L (1000 ug/L)*	5.1
Dissolved Iron (Fe)	ug/L	*0.3 mg/L (300 ug/L)*	<100
Dissolved Lead (Pb)	ug/L	0.01 mg/L (10 ug/L)	<0.50
Dissolved Magnesium (Mg)	ug/L		18000
Dissolved Manganese (Mn)	ug/L	*0.05 mg/L (50 ug/L)*	<2.0
Dissolved Molybdenum (Mo)	ug/L		<0.50
Dissolved Nickel (Ni)	ug/L		<1.0
Dissolved Phosphorus (P)	ug/L		<100
Dissolved Potassium (K)	ug/L		380
Dissolved Selenium (Se)	ug/L	0.05 mg/L (50 ug/L)	<2.0
Dissolved Silicon (Si)	ug/L		4700
Dissolved Silver (Ag)	ug/L		<0.10
Dissolved Sodium (Na)	ug/L	20 mg/L (20000 ug/L)	1700
	ug/L	*200 mg/L (200000 ug/L)*	1700
Dissolved Strontium (Sr)	ug/L		170
Dissolved Thallium (Tl)	ug/L		<0.050
Dissolved Titanium (Ti)	ug/L		<5.0
Dissolved Uranium (U)	ug/L	0.02 mg/L (20 ug/L)	0.19
Dissolved Vanadium (V)	ug/L		<0.50
Dissolved Zinc (Zn)	ug/L	*5 mg/L (5000 ug/L)*	5.9

Notes:

ODWS - Denotes Ontario Drinking Water Standards

black font - maximum allowable concentrations

blue italics - aesthetic objectives

Results denote exceedance on Max. Allowable Conc.
Results denote exceedance on aesthetic objectives.

Results Reviewed By:

Rebecca Walker, P.Eng.

LDS LONSULTANTS INC.

Maxxam
A Bureau Veritas Group Company

Your Project #: VANSEVENANT
Your C.O.C. #: 695985-01-01

Attention: Rebecca Walker

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

Report Date: 2018/12/21
Report #: R5536370
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8X8971
Received: 2018/12/18, 09:20

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	2	N/A	2018/12/20	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	2	N/A	2018/12/21	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	2	N/A	2018/12/21	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2018/12/20	CAM SOP-00414	SM 23 2510 m
Dissolved Organic Carbon (DOC) (1)	2	N/A	2018/12/20	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3)	2	N/A	2018/12/20	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	2	N/A	2018/12/20	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	2	N/A	2018/12/21		
Anion and Cation Sum	2	N/A	2018/12/21		
Total Ammonia-N	2	N/A	2018/12/21	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	2	N/A	2018/12/20	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH	2	N/A	2018/12/20	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	2	N/A	2018/12/21	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2018/12/21		
Sat. pH and Langelier Index (@ 4C)	2	N/A	2018/12/21		
Sulphate by Automated Colourimetry	2	N/A	2018/12/21	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	2	N/A	2018/12/21		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam 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.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their

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Your Project #: VANSEVENANT
Your C.O.C. #: 695985-01-01

Attention: Rebecca Walker

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

Report Date: 2018/12/21
Report #: R5536370
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8X8971
Received: 2018/12/18, 09:20
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 Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
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: CGripton@maxxam.ca
Phone# (800)268-7396 Ext:250
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

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Maxxam Job #: B8X8971
Report Date: 2018/12/21

LDS Consultants Inc
Client Project #: VANSEVENANT
Sampler Initials: RW

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IOX374	IOX375		
Sampling Date		2018/12/17	2018/12/17		
COC Number		695985-01-01	695985-01-01		
	UNITS	**BH3**	**BH8**	**RDL**	**QC Batch**
Calculated Parameters					
Anion Sum	me/L	5.66	6.37	N/A	5896940
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	190	230	1.0	5896928
Calculated TDS	mg/L	310	360	1.0	5896943
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.7	1.6	1.0	5896928
Cation Sum	me/L	5.52	6.05	N/A	5896940
Hardness (CaCO3)	mg/L	270	300	1.0	5896938
Ion Balance (% Difference)	%	1.27	2.59	N/A	5896939
Langelier Index (@ 20C)	N/A	0.712	0.755		5896941
Langelier Index (@ 4C)	N/A	0.463	0.506		5896942
Saturation pH (@ 20C)	N/A	7.25	7.12		5896941
Saturation pH (@ 4C)	N/A	7.50	7.37		5896942
Inorganics					
Total Ammonia-N	mg/L	<0.050	<0.050	0.050	5899587
Conductivity	umho/cm	520	600	1.0	5899782
Dissolved Organic Carbon	mg/L	1.9	<0.50	0.50	5897799
Orthophosphate (P)	mg/L	<0.010	<0.010	0.010	5900092
pH	pH	7.96	7.87		5899783
Dissolved Sulphate (SO4)	mg/L	72	3.1	1.0	5900086
Alkalinity (Total as CaCO3)	mg/L	190	230	1.0	5899780
Dissolved Chloride (Cl-)	mg/L	9.7	12	1.0	5900075
Nitrite (N)	mg/L	<0.010	<0.010	0.010	5899348
Nitrate (N)	mg/L	0.22	18.4	0.10	5899348
Nitrate + Nitrite (N)	mg/L	0.22	18.4	0.10	5899348
Metals					
Dissolved Aluminum (Al)	ug/L	<5.0	<5.0	5.0	5899057
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	5899057
Dissolved Arsenic (As)	ug/L	<1.0	<1.0	1.0	5899057
Dissolved Barium (Ba)	ug/L	18	7.1	2.0	5899057
Dissolved Beryllium (Be)	ug/L	<0.50	<0.50	0.50	5899057
Dissolved Boron (B)	ug/L	15	<10	10	5899057
Dissolved Cadmium (Cd)	ug/L	<0.10	<0.10	0.10	5899057
Dissolved Calcium (Ca)	ug/L	77000	89000	200	5899057
Dissolved Chromium (Cr)	ug/L	<5.0	<5.0	5.0	5899057
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	0.50	5899057
Dissolved Copper (Cu)	ug/L	3.9	5.1	1.0	5899057

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

Maxxam Job #: B8X8971
Report Date: 2018/12/21

LDS Consultants Inc
Client Project #: VANSEVENANT
Sampler Initials: RW

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IOX374	IOX375		
Sampling Date		2018/12/17	2018/12/17		
COC Number		695985-01-01	695985-01-01		
	UNITS	**BH3**	**BH8**	**RDL**	**QC Batch**
Dissolved Iron (Fe)	ug/L	<100	<100	100	5899057
Dissolved Lead (Pb)	ug/L	<0.50	<0.50	0.50	5899057
Dissolved Magnesium (Mg)	ug/L	19000	18000	50	5899057
Dissolved Manganese (Mn)	ug/L	4.4	<2.0	2.0	5899057
Dissolved Molybdenum (Mo)	ug/L	0.96	<0.50	0.50	5899057
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	1.0	5899057
Dissolved Phosphorus (P)	ug/L	<100	<100	100	5899057
Dissolved Potassium (K)	ug/L	680	380	200	5899057
Dissolved Selenium (Se)	ug/L	<2.0	<2.0	2.0	5899057
Dissolved Silicon (Si)	ug/L	4900	4700	50	5899057
Dissolved Silver (Ag)	ug/L	<0.10	<0.10	0.10	5899057
Dissolved Sodium (Na)	ug/L	2500	1700	100	5899057
Dissolved Strontium (Sr)	ug/L	130	170	1.0	5899057
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	0.050	5899057
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	5899057
Dissolved Uranium (U)	ug/L	0.98	0.19	0.10	5899057
Dissolved Vanadium (V)	ug/L	<0.50	<0.50	0.50	5899057
Dissolved Zinc (Zn)	ug/L	<5.0	5.9	5.0	5899057

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5897799	KRM	Matrix Spike	Dissolved Organic Carbon	2018/12/20		93	%	80 - 120
5897799	KRM	Spiked Blank	Dissolved Organic Carbon	2018/12/20		99	%	80 - 120
5897799	KRM	Method Blank	Dissolved Organic Carbon	2018/12/20	<0.50		mg/L	
5897799	KRM	RPD	Dissolved Organic Carbon	2018/12/20	1.9		%	20
5899057	ADA	Matrix Spike [IOX374-04]	Dissolved Aluminum (Al)	2018/12/20		110	%	80 - 120
			Dissolved Antimony (Sb)	2018/12/20		114	%	80 - 120
			Dissolved Arsenic (As)	2018/12/20		109	%	80 - 120
			Dissolved Barium (Ba)	2018/12/20		109	%	80 - 120
			Dissolved Beryllium (Be)	2018/12/20		104	%	80 - 120
			Dissolved Boron (B)	2018/12/20		100	%	80 - 120
			Dissolved Cadmium (Cd)	2018/12/20		111	%	80 - 120
			Dissolved Calcium (Ca)	2018/12/20		NC	%	80 - 120
			Dissolved Chromium (Cr)	2018/12/20		103	%	80 - 120
			Dissolved Cobalt (Co)	2018/12/20		110	%	80 - 120
			Dissolved Copper (Cu)	2018/12/20		110	%	80 - 120
			Dissolved Iron (Fe)	2018/12/20		112	%	80 - 120
			Dissolved Lead (Pb)	2018/12/20		106	%	80 - 120
			Dissolved Magnesium (Mg)	2018/12/20		107	%	80 - 120
			Dissolved Manganese (Mn)	2018/12/20		108	%	80 - 120
			Dissolved Molybdenum (Mo)	2018/12/20		109	%	80 - 120
			Dissolved Nickel (Ni)	2018/12/20		105	%	80 - 120
			Dissolved Phosphorus (P)	2018/12/20		103	%	80 - 120
			Dissolved Potassium (K)	2018/12/20		110	%	80 - 120
			Dissolved Selenium (Se)	2018/12/20		109	%	80 - 120
			Dissolved Silicon (Si)	2018/12/20		110	%	80 - 120
			Dissolved Silver (Ag)	2018/12/20		56 (1)	%	80 - 120
			Dissolved Sodium (Na)	2018/12/20		109	%	80 - 120
			Dissolved Strontium (Sr)	2018/12/20		109	%	80 - 120
			Dissolved Thallium (Tl)	2018/12/20		109	%	80 - 120
			Dissolved Titanium (Ti)	2018/12/20		107	%	80 - 120
			Dissolved Uranium (U)	2018/12/20		109	%	80 - 120
			Dissolved Vanadium (V)	2018/12/20		109	%	80 - 120
			Dissolved Zinc (Zn)	2018/12/20		109	%	80 - 120
5899057	ADA	Spiked Blank	Dissolved Aluminum (Al)	2018/12/20		102	%	80 - 120
			Dissolved Antimony (Sb)	2018/12/20		99	%	80 - 120
			Dissolved Arsenic (As)	2018/12/20		99	%	80 - 120
			Dissolved Barium (Ba)	2018/12/20		98	%	80 - 120
			Dissolved Beryllium (Be)	2018/12/20		99	%	80 - 120
			Dissolved Boron (B)	2018/12/20		96	%	80 - 120
			Dissolved Cadmium (Cd)	2018/12/20		101	%	80 - 120
			Dissolved Calcium (Ca)	2018/12/20		98	%	80 - 120
			Dissolved Chromium (Cr)	2018/12/20		93	%	80 - 120
			Dissolved Cobalt (Co)	2018/12/20		97	%	80 - 120
			Dissolved Copper (Cu)	2018/12/20		96	%	80 - 120
			Dissolved Iron (Fe)	2018/12/20		99	%	80 - 120
			Dissolved Lead (Pb)	2018/12/20		99	%	80 - 120
			Dissolved Magnesium (Mg)	2018/12/20		102	%	80 - 120
			Dissolved Manganese (Mn)	2018/12/20		98	%	80 - 120
			Dissolved Molybdenum (Mo)	2018/12/20		98	%	80 - 120
			Dissolved Nickel (Ni)	2018/12/20		96	%	80 - 120
			Dissolved Phosphorus (P)	2018/12/20		105	%	80 - 120
			Dissolved Potassium (K)	2018/12/20		100	%	80 - 120
			Dissolved Selenium (Se)	2018/12/20		102	%	80 - 120
			Dissolved Silicon (Si)	2018/12/20		104	%	80 - 120

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Maxxam Job #: B8X8971
Report Date: 2018/12/21

LDS Consultants Inc
Client Project #: VANSEVENANT
Sampler Initials: RW

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Silver (Ag)	2018/12/20		97	%	80 - 120
			Dissolved Sodium (Na)	2018/12/20		98	%	80 - 120
			Dissolved Strontium (Sr)	2018/12/20		100	%	80 - 120
			Dissolved Thallium (Tl)	2018/12/20		102	%	80 - 120
			Dissolved Titanium (Ti)	2018/12/20		98	%	80 - 120
			Dissolved Uranium (U)	2018/12/20		101	%	80 - 120
			Dissolved Vanadium (V)	2018/12/20		97	%	80 - 120
			Dissolved Zinc (Zn)	2018/12/20		100	%	80 - 120
5899057	ADA	Method Blank	Dissolved Aluminum (Al)	2018/12/20	<5.0		ug/L	
			Dissolved Antimony (Sb)	2018/12/20	<0.50		ug/L	
			Dissolved Arsenic (As)	2018/12/20	<1.0		ug/L	
			Dissolved Barium (Ba)	2018/12/20	<2.0		ug/L	
			Dissolved Beryllium (Be)	2018/12/20	<0.50		ug/L	
			Dissolved Boron (B)	2018/12/20	<10		ug/L	
			Dissolved Cadmium (Cd)	2018/12/20	<0.10		ug/L	
			Dissolved Calcium (Ca)	2018/12/20	<200		ug/L	
			Dissolved Chromium (Cr)	2018/12/20	<5.0		ug/L	
			Dissolved Cobalt (Co)	2018/12/20	<0.50		ug/L	
			Dissolved Copper (Cu)	2018/12/20	<1.0		ug/L	
			Dissolved Iron (Fe)	2018/12/20	<100		ug/L	
			Dissolved Lead (Pb)	2018/12/20	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2018/12/20	<50		ug/L	
			Dissolved Manganese (Mn)	2018/12/20	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2018/12/20	<0.50		ug/L	
			Dissolved Nickel (Ni)	2018/12/20	<1.0		ug/L	
			Dissolved Phosphorus (P)	2018/12/20	<100		ug/L	
			Dissolved Potassium (K)	2018/12/20	<200		ug/L	
			Dissolved Selenium (Se)	2018/12/20	<2.0		ug/L	
			Dissolved Silicon (Si)	2018/12/20	<50		ug/L	
			Dissolved Silver (Ag)	2018/12/20	<0.10		ug/L	
			Dissolved Sodium (Na)	2018/12/20	<100		ug/L	
			Dissolved Strontium (Sr)	2018/12/20	<1.0		ug/L	
			Dissolved Thallium (Tl)	2018/12/20	<0.050		ug/L	
			Dissolved Titanium (Ti)	2018/12/20	<5.0		ug/L	
			Dissolved Uranium (U)	2018/12/20	<0.10		ug/L	
			Dissolved Vanadium (V)	2018/12/20	<0.50		ug/L	
			Dissolved Zinc (Zn)	2018/12/20	<5.0		ug/L	
5899057	ADA	RPD [IOX374-04]	Dissolved Aluminum (Al)	2018/12/20	NC		%	20
			Dissolved Antimony (Sb)	2018/12/20	NC		%	20
			Dissolved Arsenic (As)	2018/12/20	NC		%	20
			Dissolved Barium (Ba)	2018/12/20	0.47		%	20
			Dissolved Beryllium (Be)	2018/12/20	NC		%	20
			Dissolved Boron (B)	2018/12/20	1.6		%	20
			Dissolved Cadmium (Cd)	2018/12/20	NC		%	20
			Dissolved Calcium (Ca)	2018/12/20	1.5		%	20
			Dissolved Chromium (Cr)	2018/12/20	NC		%	20
			Dissolved Cobalt (Co)	2018/12/20	NC		%	20
			Dissolved Copper (Cu)	2018/12/20	2.4		%	20
			Dissolved Iron (Fe)	2018/12/20	NC		%	20
			Dissolved Lead (Pb)	2018/12/20	NC		%	20
			Dissolved Magnesium (Mg)	2018/12/20	0.89		%	20
			Dissolved Manganese (Mn)	2018/12/20	0.16		%	20
			Dissolved Molybdenum (Mo)	2018/12/20	6.9		%	20
			Dissolved Nickel (Ni)	2018/12/20	NC		%	20

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Maxxam Job #: B8X8971
Report Date: 2018/12/21

LDS Consultants Inc
Client Project #: VANSEVENANT
Sampler Initials: RW

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Phosphorus (P)	2018/12/20	NC		%	20
			Dissolved Potassium (K)	2018/12/20	1.9		%	20
			Dissolved Selenium (Se)	2018/12/20	NC		%	20
			Dissolved Silicon (Si)	2018/12/20	0.46		%	20
			Dissolved Silver (Ag)	2018/12/20	NC		%	20
			Dissolved Sodium (Na)	2018/12/20	2.3		%	20
			Dissolved Strontium (Sr)	2018/12/20	3.2		%	20
			Dissolved Thallium (Tl)	2018/12/20	NC		%	20
			Dissolved Titanium (Ti)	2018/12/20	NC		%	20
			Dissolved Uranium (U)	2018/12/20	3.5		%	20
			Dissolved Vanadium (V)	2018/12/20	NC		%	20
			Dissolved Zinc (Zn)	2018/12/20	NC		%	20
5899348	C_N	Matrix Spike	Nitrite (N)	2018/12/20		104	%	80 - 120
			Nitrate (N)	2018/12/20		103	%	80 - 120
5899348	C_N	Spiked Blank	Nitrite (N)	2018/12/20		105	%	80 - 120
			Nitrate (N)	2018/12/20		102	%	80 - 120
5899348	C_N	Method Blank	Nitrite (N)	2018/12/20	<0.010		mg/L	
			Nitrate (N)	2018/12/20	<0.10		mg/L	
5899348	C_N	RPD	Nitrite (N)	2018/12/20	NC		%	20
			Nitrate (N)	2018/12/20	NC		%	20
5899587	COP	Matrix Spike	Total Ammonia-N	2018/12/21		NC	%	75 - 125
5899587	COP	Spiked Blank	Total Ammonia-N	2018/12/21		101	%	80 - 120
5899587	COP	Method Blank	Total Ammonia-N	2018/12/21	<0.050		mg/L	
5899587	COP	RPD	Total Ammonia-N	2018/12/21	0.19		%	20
5899780	NYS	Spiked Blank	Alkalinity (Total as CaCO3)	2018/12/20		95	%	85 - 115
5899780	NYS	Method Blank	Alkalinity (Total as CaCO3)	2018/12/20	<1.0		mg/L	
5899780	NYS	RPD	Alkalinity (Total as CaCO3)	2018/12/20	0.97		%	20
5899782	NYS	Spiked Blank	Conductivity	2018/12/20		100	%	85 - 115
5899782	NYS	Method Blank	Conductivity	2018/12/20	<1.0		umho/cm	
5899782	NYS	RPD	Conductivity	2018/12/20	0.97		%	25
5899783	NYS	Spiked Blank	pH	2018/12/20		101	%	98 - 103
5899783	NYS	RPD	pH	2018/12/20	1.1		%	N/A
5900075	DRM	Matrix Spike	Dissolved Chloride (Cl-)	2018/12/21		NC	%	80 - 120
5900075	DRM	Spiked Blank	Dissolved Chloride (Cl-)	2018/12/21		106	%	80 - 120
5900075	DRM	Method Blank	Dissolved Chloride (Cl-)	2018/12/21	<1.0		mg/L	
5900075	DRM	RPD	Dissolved Chloride (Cl-)	2018/12/21	4.3		%	20
5900086	DRM	Matrix Spike	Dissolved Sulphate (SO4)	2018/12/21		NC	%	75 - 125
5900086	DRM	Spiked Blank	Dissolved Sulphate (SO4)	2018/12/21		106	%	80 - 120
5900086	DRM	Method Blank	Dissolved Sulphate (SO4)	2018/12/21	<1.0		mg/L	
5900086	DRM	RPD	Dissolved Sulphate (SO4)	2018/12/21	1.6		%	20
5900092	DRM	Matrix Spike	Orthophosphate (P)	2018/12/21		101	%	75 - 125
5900092	DRM	Spiked Blank	Orthophosphate (P)	2018/12/21		100	%	80 - 120
5900092	DRM	Method Blank	Orthophosphate (P)	2018/12/21	<0.010		mg/L	

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Maxxam Job #: B8X8971
Report Date: 2018/12/21

LDS Consultants Inc
Client Project #: VANSEVENANT
Sampler Initials: RW

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5900092	DRM	RPD	Orthophosphate (P)	2018/12/21	9.2		%	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).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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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

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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APPENDIX D

SINGLE WELL RESPONSE TESTS

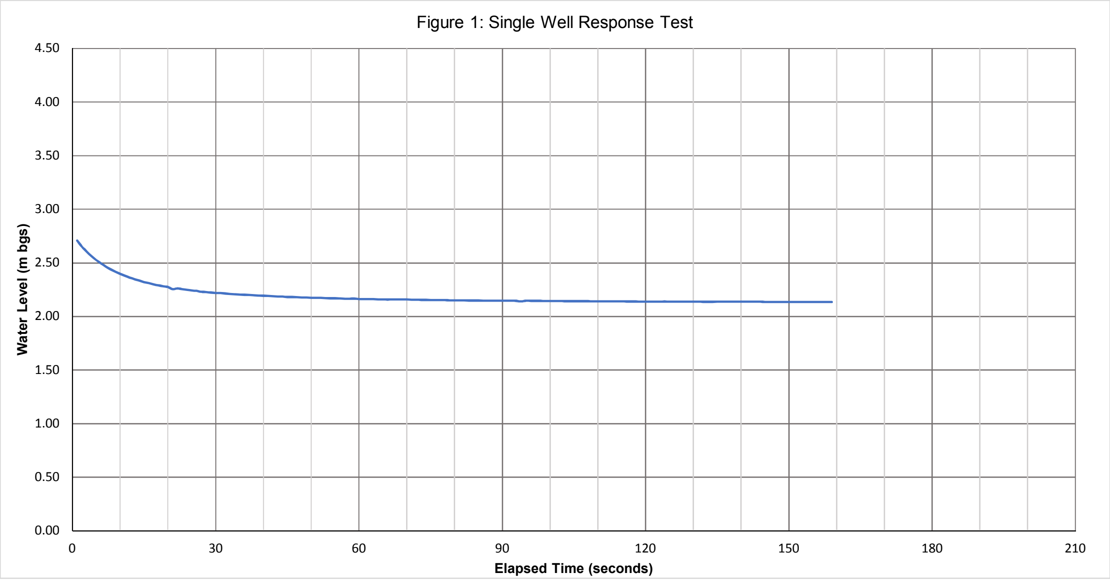
SINGLE WELL RESPONSE TEST
Estimation of Saturated Hydraulic Conductivity from Well Recovery Data

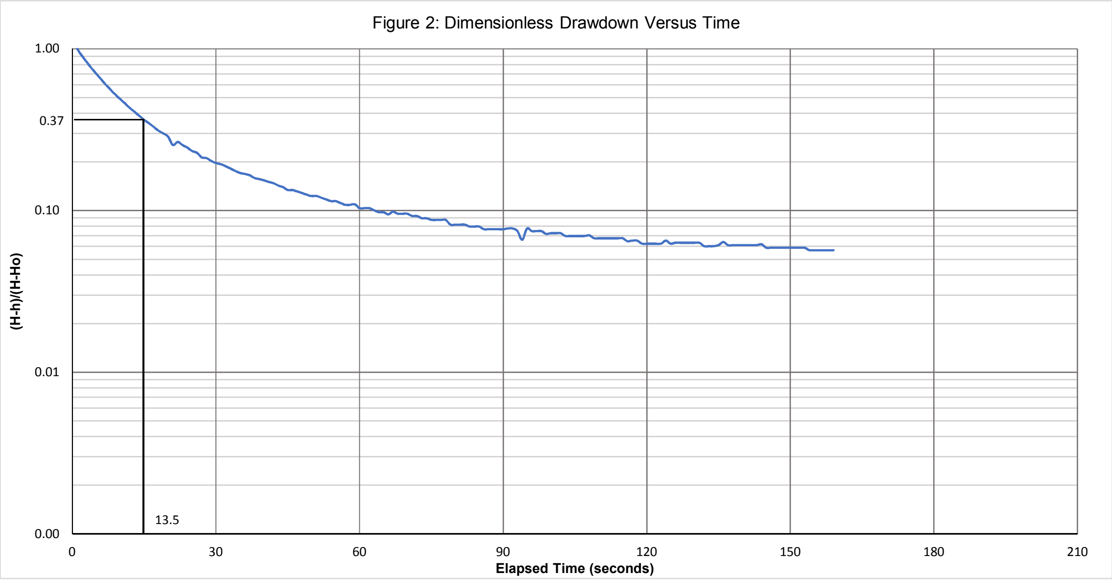
BH1/MW

Project No.	**GE-00103**	**Monitoring Well ID**	**BH1/MW**
Project Name	**Vansevenant**	**Date of Testing**	**19-Dec-18**

Well Data:

Radius of well casing, r,(m) =	0.025	Data Logger S/N:	20246303
Radius of filter pack/borehole, R, (m) =	0.101	Reading Interval:	1 second
Length of well screen, L, (m) =	3.05		
Submerged well screen length, Ls, (m) =	3.05	Gravel Pack Correctior $R_{equiv} = [(1-n)r^2 + nR^2]^{½}$	0.070
Static water level, h, (m) =	2.10		
Porosity of Gravel Pack, n (%) =	0.45		





Estimation of Saturated Hydraulic Conductivity From Hvorslev's Equation

Hvorslev's Equation: $K = \frac{r^2(\ln(L/R))}{2(To)(L)}$ for L/R > 8

where

K = Hydraulic Conductivity (m/s)
r = Radius of the well casing (m)
R = Radius of the well screen (m)
L = Length of the submerged portion of the well screen under static conditions (m)
To = Basic time lag; time for water level to rise or fall to 37% of the initial change (Sec)

Check if L/R > 8	L/R =	30.2	
Evaluation of basic time lag	To=	13.5	sec
Estimated Saturated Hydraulic Conductivity	**K=**	**2.86E-05**	**m/sec**

LDS

SINGLE WELL RESPONSE TEST
Estimation of Saturated Hydraulic Conductivity from Well Recovery Data

BH5/MW

Project No.	**GE-00103**	**Monitoring Well ID**	**BH5/MW**
Project Name	**Vansevenant**	**Date of Testing**	**19-Dec-18**

Well Data:

Radius of well casing, r,(m) =	0.025	Data Logger S/N:	20246303
Radius of filter pack/borehole, R, (m) =	0.101	Reading Interval:	1 second
Length of well screen, L, (m) =	3.05		
Submerged well screen length, Ls, (m) =	3.05	Gravel Pack Correctior $R_{equiv} = [(1-n)r^2 + nR^2]^{1/2}$	0.070
Static water level, h, (m) =	0.66		
Porosity of Gravel Pack, n (%) =	0.45		

Figure 1: Single Well Response Test

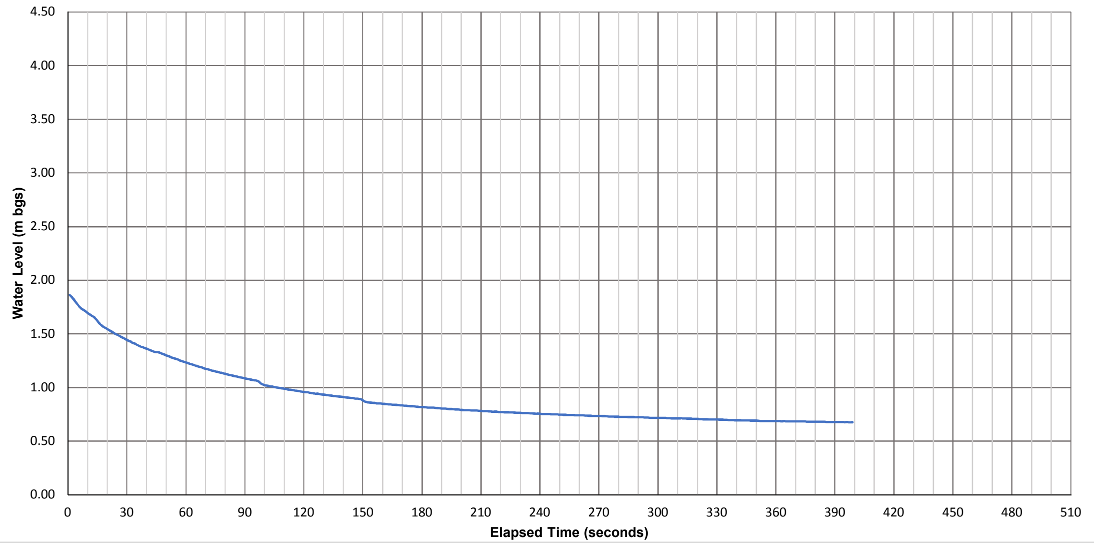
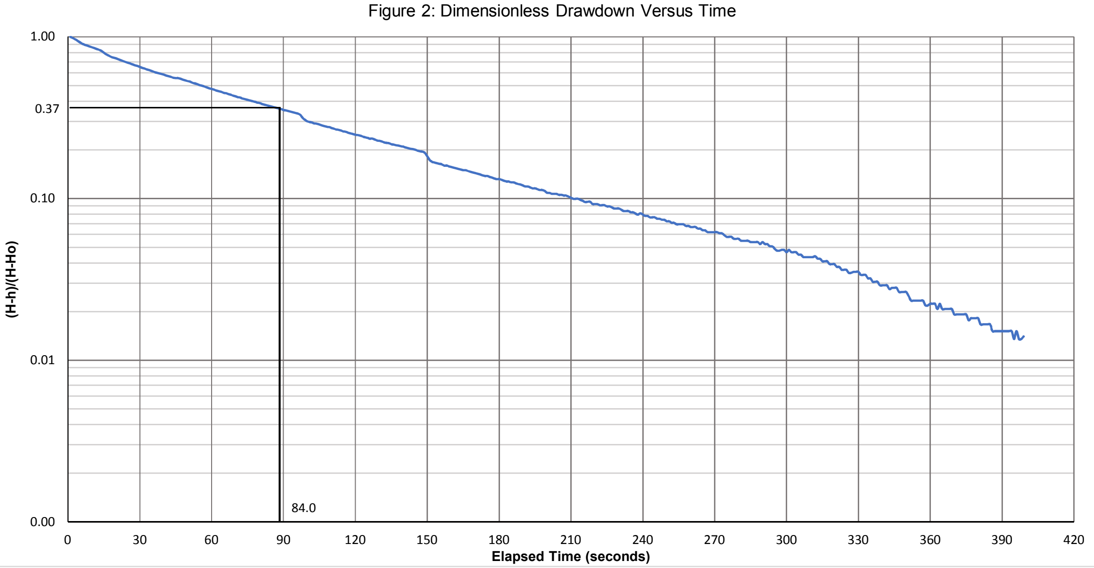


Figure 2: Dimensionless Drawdown Versus Time



Estimation of Saturated Hydraulic Conductivity From Hvorslev's Equation

Hvorslev's Equation: $K = \frac{r^2(\ln(L/R))}{2(To)(L)}$ for L/R > 8

where

K = Hydraulic Conductivity (m/s)
r = Radius of the well casing (m)
R = Radius of the well screen (m)
L = Length of the submerged portion of the well screen under static conditions (m)
To = Basic time lag; time for water level to rise or fall to 37% of the initial change (Sec)

Check if L/R > 8	L/R =	30.2	
Evaluation of basic time lag	To=	84.0	sec
Estimated Saturated Hydraulic Conductivity	**K=**	**4.60E-06**	**m/sec**

APPENDIX E

WATER BALANCE WORKSHEETS

Sheet 1 - Preliminary Water Balance and Infiltration Calculations
Edgewood West Subdivision

Existing (Pre-Development) Drainage Conditions

Catchment Characteristics				Pervious Only Amounts				Site Specific Volumes		
Catchment	Soil Conditions	Area (ha)	% Impervious	Precipitation	Actual ET	Infiltration	Runoff	Actual ET (m^3)	Infil From Perv. (mm)	INFIL (m^3)
101	Sand, Silty Sand- Hydrologic Group A	2.20	0%	1023	542	336	144	11,934	336	7,400
102	Sand, Silty Sand- Hydrologic Group A	5.10	0%	1023	542	336	144	27,665	336	17,156
103	Sand, Silty Sand- Hydrologic Group A	0.70	0%	1023	542	336	144	3,797	336	2,355
104	Sand, Silty Sand- Hydrologic Group A	7.80	0%	1023	564	367	92	44,015	367	28,623
105	Sand, Silty Sand- Hydrologic Group A	2.90	0%	1023	542	336	144	15,731	336	9,755
106	Sand, Silty Sand- Hydrologic Group A	2.00	0%	1023	542	336	144	10,849	336	6,728
	Total Area (Ha)	20.70						113,991		72,017

Catchment	Soil Conditions	Precipitation	Actual ET	Infiltration	Runoff	Units
106	Sand, Silty Sand- Hydrologic Group A	20,460	10,849	6,728	2,883	m^3/yr
	Northern Woodlot Total	20,460	10,849	6,728	2,883	m^3/yr
104	Sand, Silty Sand- Hydrologic Group A	79,794	44,015	28,623	7,156	m^3/yr
	Western Woodlot Total	79,794	44,015	28,623	7,156	m^3/yr
101	Sand, Silty Sand- Hydrologic Group A	22,506	11,934	7,400	3,172	m^3/yr
102	Sand, Silty Sand- Hydrologic Group A	52,173	27,665	17,156	7,352	m^3/yr
103	Sand, Silty Sand- Hydrologic Group A	7,161	3,797	2,355	1,009	m^3/yr
105	Sand, Silty Sand- Hydrologic Group A	29,667	15,731	9,755	4,181	m^3/yr
	Ravine System Total	111,507	59,127	36,666	15,714	m^3/yr
	Total	211,761	113,991	72,017	25,753	m^3/yr

Post Development Drainage Conditions

Catchment Characteristics				Pervious Only Amounts				Site Specific Volumes		
Catchment	Soil Conditions	Area (ha)	% Impervious	Precipitation	Actual ET	Infiltration	Runoff	Actual ET (m^3)	Infil From Perv. (mm)	INFIL (m^3)
201	Sand, Silty Sand- Hydrologic Group A	1.40	15%	1023	564	367	92	7,900	312	4,367
202	Sand, Silty Sand- Hydrologic Group A	3.70	50%	1023	241	548	235	8,910	274	10,129
203	Sand, Silty Sand- Hydrologic Group A	8.30	5%	1023	564	367	92	46,837	349	28,935
204	Sand, Silty Sand- Hydrologic Group A	5.10	50%	1023	241	548	235	12,281	274	13,962
205	Sand, Silty Sand- Hydrologic Group A	2.10	10%	1023	241	548	235	5,057	493	10,349
	Totals	20.60						80,984		67,742

Catchment	Soil Conditions	Precipitation	Actual ET	Infiltration	Runoff	Units
201	Sand, Silty Sand- Hydrologic Group A	14,322	7,900	4,367	2,055	m^3/yr
	Northern Woodlot Total	14,322	7,900	4,367	2,055	m^3/yr
203	Sand, Silty Sand- Hydrologic Group A	84,909	46,837	28,935	9,137	m^3/yr
	Western Woodlot Total	84,909	46,837	28,935	9,137	m^3/yr
202	Sand, Silty Sand- Hydrologic Group A	37,851	8,910	10,129	18,812	m^3/yr
204	Sand, Silty Sand- Hydrologic Group A	52,173	12,281	13,962	25,930	m^3/yr
205	Sand, Silty Sand- Hydrologic Group A	21,483	5,057	10,349	6,078	m^3/yr
	Ravine System Total	111,507	26,247	34,440	50,820	m^3/yr
	Total	210,738	80,984	67,742	62,012	m^3/yr

Change in Water Balance Parameters Contributing to the Northern Woodlot	Net Change in Infiltration Volume	-2,361	m^3/yr
	Net Change in Evapotranspiration Volume	-2,949	m^3/yr
	Net Change in Runoff Volume	-828	m^3/yr
Change in Water Balance Parameters Contributing to the Western Woodlot	Net Change in Infiltration Volume	312	m^3/yr
	Net Change in Evapotranspiration Volume	2,822	m^3/yr
	Net Change in Runoff Volume	1,982	m^3/yr
Change in Water Balance Parameters Contributing to the Ravine System	Net Change in Infiltration Volume	-2,226	m^3/yr
	Net Change in Evapotranspiration Volume	-32,880	m^3/yr
	Net Change in Runoff Volume	35,106	m^3/yr

NOTES:
(1) Precipitation based on: *Canadian Climate Normals at Delhi,Ontario for 1981-2010 - Provided on Environment Canada website.*
(2) Evapotranspiration values based on MOE SWMPD Manual (2003), Table 3.1 Hydrologic Cycle Component Values, prorated to local precipitation.
(3) Infiltration rate based on: *MOE SWMPD Manual (2003), Table 3.1 Hydrologic Cycle Component Values, prorated to local precipitation.*
(4) Application of model on impervious surfaces results in zero (0) INFIL. All precipitation falling on impervious areas is converted to runoff and ET.
(5) Alpha values used to calculate Actual ET are found in *TRCA (2014), Measurement of Evaptranspiration Across Different Land Cover Types in the Greater Toronto Area, Table 1*

Z:\1614-00142 - Parkhouse Drive Subdivision (Vansevenant) - Mt. Brydges\Detail Design\Reports\SWM\Water Balance\[161400142 20190228 Water Balance.xlsx]Water Balance

Sheet 2 - Water Balance Source Data

Existing Conditions (Pre-Development)

Catchment & Description	Water Holding Capacity (mm)	Hydrologic Soil Group	Precipitation * (mm)	Potential Evapo-transpiration (mm)	Alpha	Actual Evapo-transpriation (mm)	Surplus Water (mm)	Infiltration (mm)	Runoff (mm)	Total Infiltration Factor	Cover Factor	Topography Factor	Soils Factor
Moderately Rooted Crops	75	A-Sand, Silty Sand	1023	571	0.95	542	481	336	144	0.70	0.1	0.2	0.40
Mature Woodlot	250	A-Sand, Silty Sand	1023	594	0.95	564	459	367	92	0.80	0.2	0.2	0.40

Refer to Notes below.

Post-Development

Catchment & Description	Water Holding Capacity (mm)	Hydrologic Soil Group	Precipitation (mm)	Potential Evapo-transpiration (mm)	Alpha	Actual Evapo-transpriation (mm)	Surplus Water (mm)	Infiltration (mm)	Runoff (mm)	Total Infiltration Factor	Cover Factor	Topography Factor	Soils Factor
Urban Lawns	50	A-Sand, Silty Sand	1023	560	0.43	241	782	548	235	0.70	0.1	0.2	0.40
Mature Woodlot	250	A-Sand, Silty Sand	1023	594	0.95	564	459	367	92	0.80	0.2	0.2	0.40

Process and Assumptions

1) Precipitation based on: Canadian Climate Normals at Strathroy, ON for 1981-2010, *www.climate.weather.gc.ca/climate_normals*
2) Pro-rate the potential evapotranspiration (ET) depth based on relationship shown on Table 3.1: Hydrologic Cycle Component Values", Stormwater Management Planning and Design Manual, MOE, 2003 and local precipitation data
3) Calculate Actual ET using a value for alpha (see Sheet 3)
3) Choose and sum infiltration (INFIL) factors based on "Table 3.1: Hydrologic Cycle Component Values", Stormwater Management Planning and Design Manual, MOE, 2003
4) Apply total infiltration factor to surplus water to obtain runoff and infiltration depths
5) Calculate ET and INFIL volumes based on catchment areas
6) Back calculate for runoff volume based on ET, INFIL and total precipitation volumes.

Sheet 3 - Supporting Tables

MOE SWMPD Manual, Table 3.1

Table 3.1: Hydrologic Cycle Component Values

	Water Holding Capacity mm	Hydrologic Soil Group	Precipitation mm	Evapo-transpiration mm	Runoff mm	Infiltration* mm
Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)						
Fine Sand	50	A	940	515	149	276
Fine Sandy Loam	75	B	940	525	187	228
Silt Loam	125	C	940	536	222	182
Clay Loam	100	CD	940	531	245	164
Clay	75	D	940	525	270	145
Moderately Rooted Crops (corn and cereal grains)						
Fine Sand	75	A	940	525	125	291
Fine Sandy Loam	150	B	940	539	160	241
Silt Loam	200	C	940	543	199	199
Clay Loam	200	CD	940	543	218	179
Clay	150	D	940	539	241	160
Pasture and Shrubs						
Fine Sand	100	A	940	531	102	307
Fine Sandy Loam	150	B	940	539	140	261
Silt Loam	250	C	940	546	177	217
Clay Loam	250	CD	940	546	197	197
Clay	200	D	940	543	218	179
Mature Forests						
Fine Sand	250	A	940	546	79	315
Fine Sandy Loam	300	B	940	548	118	274
Silt Loam	400	C	940	550	156	234
Clay Loam	400	CD	940	550	176	215
Clay	350	D	940	549	196	196

Notes: Hydrologic Soil Group A represents soils with low runoff potential and Soil Group D represents soils with high runoff potential. The evapotranspiration values are for mature vegetation. Streamflow is composed of baseflow and runoff.

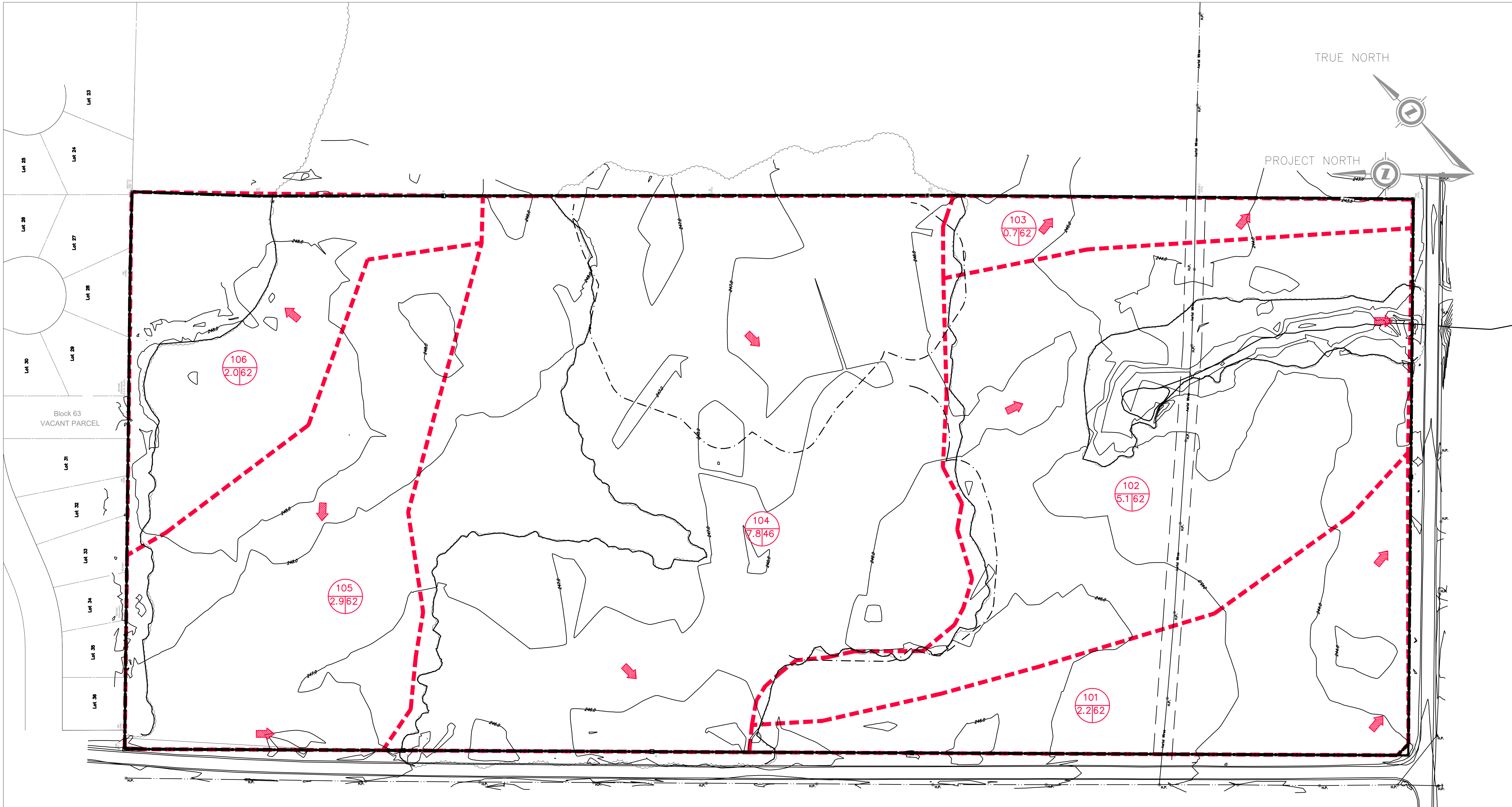
* *This is the total infiltration of which some discharges back to the stream as base flow. The infiltration factor is determined by summing a factor for topography, soils and cover.*

Topography	Flat Land, average slope < 0.6 m/km	0.3
	Rolling Land, average slope 2.8 m to 3.8 m/km	0.2
	Hilly Land, average slope 28 m to 47 m/km	0.1
Soils	Tight impervious clay	0.1
	Medium combinations of clay and loam	0.2
	Open Sandy loam	0.4
Cover	Cultivated Land	0.1
	Woodland	0.2

SWM Planning & Design Manual - 3-4 - *Environmental Design Criteria*

TRCA, Measurement of Evapotranspiration Across Different Land Cover Types in the Greater Toronto Area
Excerpt from Table 1

Land Use	Study area	Seasonal Alpha Value
Industrial	Downsview Site	0.24
Residential Industrial Mix	Richmond Hill Site	0.43
Natural Area	Kortright Site	0.95



LEGEND:

EXISTING CATCHMENT

EXISTING OVERLAND FLOW PATH

101 CATCHMENT ID

9.9 61

AREA (ha) SCS CURVE NUMBER

EDGEWOOD WEST SUBDIVISION

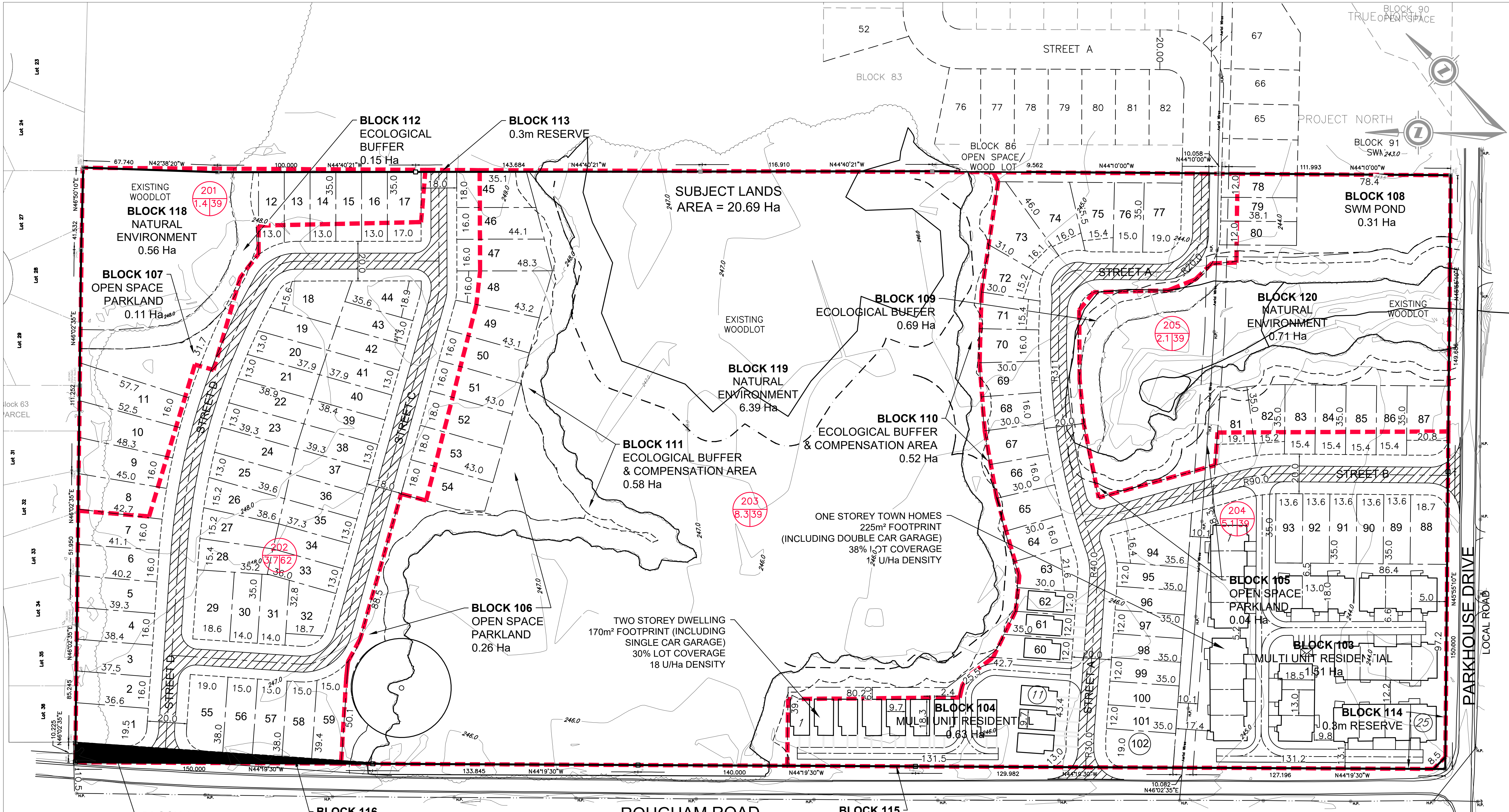
SIFTON PROPERTIES LIMITED

PRE-DEVELOPMENT CONDITIONS

PROJECT: GE-00021

SCALE: N.T.S.

FIGURE 1



LEGEND:

PROPOSED CATCHMENT

PROPOSED OVERLAND FLOW PATH

101 / 9.9 61 — CATCHMENT ID; AREA (ha); SCS CURVE NUMBER

LDS

STRATHROY-CARADOC
URBAN OPPORTUNITY - RURAL HOSPITALITY

EDGEWOOD WEST SUBDIVISION
SIFTON PROPERTIES LIMITED

POST DEVELOPMENT CONDITIONS

PROJECT: GE-00021 | SCALE: N.T.S. | FIGURE 2

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