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Preliminary Hydrogeological Assessment – M1 Property – 206105 Highway 26

Palmer Project #
2001801

Prepared For
LC Development Group (LCDG Inc.)

June 3, 2020

June 3, 2020

Angus Knowles
LC Development Group (LCDG Inc.)
909 Davenport Road, 2nd Floor
Toronto, Ontario
M6G 2B7

Dear Angus:

Re: Preliminary Hydrogeological Assessment – M1 Property – 206105 Highway 26
Project #: 2001801

Palmer is pleased to submit the following report describing the results of our Preliminary Hydrogeological Assessment to identify groundwater related concerns or constrains for development of the property at 206105 Highway 26, Meaford, ON.

This report provides site information regarding the surficial geology, bedrock mapping, nearby water wells and Source Water Protection. This report is largely based on background geological and hydrogeological data with the inclusion of limited field results from the geotechnical investigation completed by Palmer. We have provided an effects assessment based on the site conditions and provided a series of hydrogeological construction constraints for your consideration.

Overall, the site hosts a relatively deep water table and low permeability soils at surface. No significant development constraints related to groundwater conditions were identified over the majority of the site based on the results of our borehole drilling program. The area along the western boundary (as identified by BHM1-1) hosts a shallow perched water table and high permeability soils. Should development occur in this area, it is recommended that the grade should be raised so that basement foundations are at least 1 m above the perched water table. However, It should be acknowledged that other engineering solutions may be possible to keep building foundations dry.

Please let us know if you have question or comments on this submission. Thank you for the opportunity to work with your team on this project.

Yours truly,
Palmer Environmental Consulting Group Inc.

Jason Cole, M.Sc., P. Geo.
Principal, Senior Hydrogeologist

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1. Introduction

Palmer Environmental Consulting Group Inc. (Palmer) was retained by LC Development Group (LCDG Inc.) to complete a Preliminary Hydrogeological Investigation based on a desktop level study to provide groundwater considerations for a proposed subdivision development of residential buildings, internal roads, and a storm water management facility at 206105 Highway 26 in Meaford, Ontario. The site consists of two properties: M1 and M2 (**Figure 1**). This report will focus on the M1 property, located west of the intersection of Highway 26 and Algonquin Drive. The property is approximately 34 acres in size and is currently a residential property, farm field, and woodlot. The legal description of M1 is Plan 541 Part Lot 4 and Part Lot 14, RP 16R5037 Part 1.

This report provides site information regarding the surficial geology, bedrock mapping, nearby water wells and Source Water Protection. This report is largely based on background geological and hydrogeological data with the inclusion of limited field results from the geotechnical investigation completed by Palmer. We have provided an effects assessment based on the site conditions and provided a series of hydrogeological construction constraints for your considerations.

1.1 Scope of Work

Palmer's Hydrogeological Investigation was completed concurrently with Palmer's Geotechnical and Environmental Investigations and includes the following main tasks:

- Obtain and review applicable background information including surficial geology maps, MECP water well records, and other applicable hydrogeology reports from Grey Sauble Conservation and the Municipality of Meaford;
- Characterize the hydrogeology of the site based on secondary source data and the results of Palmer's geotechnical drilling program;
- Conduct rising head tests to determine the hydraulic conductivity of soils on site;
- Assess potential impacts from site development and hydrogeological development considerations; and
- Produce a Preliminary Hydrogeological Assessment Report based on the results of the desktop study.

2. Regional Conditions

2.1 Surficial Geology and Physiography

A review of available online surficial geology mapping by the Ontario Geological Survey (OGS) was used to identify the overburden materials of the site (**Figure 2**). Underlying the majority of the site is a stone-poor, carbonate derived silty to sandy glacial till deposit. This unit is found at surface on the majority of the tableland areas associated with the agricultural fields. Over the western portion of the site foreshore-basinal glaciolacustrine deposits of sand and silt are found generally associated with the wooded areas. Littoral-foreshore glaciolacustrine deposits of sand with minor silt and clay are expected to be found along

the eastern site boudary. To the south of the property, glaciolacustrine deposits of clay, silt, and occasional very fine sand can be found.

The site is situated within the Bighead Valley physiographic region as seen in **Figure 3** (Chapman and Putnam, 1984). The bed of the Bighead River, which drains this box-like valley lies about 180 m below the shoulders of hard dolostone cap rock. It was largely eroded in preglacial time and slightly modified by ice erosion. The shoulders, sides, and floor of this valley are completely covered with drumlins. Another feature of this valley is the abandoned shoreline of Lake Algonquin marked by a barrier beach found approximately 4 km inland from the present shoreline of Georgian Bay and approximately 60 m higher elevation. The site is also expected to have a northwest trending former shorecliff feature within it.

2.2 Drainage

The site is found approximately 300 m east of the shoreline of southern portion of Georgian Bay. Multiple small creeks can be found surrounding the site, with the most notable being Centreville Creek intersecting a portion of the site to the north, and Margret Marshall Saunders Creek to the south.

2.3 Bedrock Geology

The bedrock underlying the study area consists of the Georgian Bay Formation (**Figure 4**), which overlies the nearby Blue Mountain Formation (Armstrong and Dodge, 2007). The Georgian Bay Formation consists of interbedded grey-green to dark grey shale and fossiliferous calcareous siltstone to limestone. According to nearby water well records, bedrock is found at approximately 15 metres below ground surface (mbgs). The underlying Blue Mountain Formation is characterised as dark blue-grey to brown to black shale with thin interbeds of limestone or calcareous siltstone.

2.4 MECP Water Wells

Based on a review of the Ministry of the Environment, Conservation and Parks (MECP) water well record database, 11 water wells are situated within a 500 m radius of the project boundary (**Figure 5**). Of the water wells, 8 are for domestic use, 1 is for livestock, and 2 are not used. All of the wells are completed in the bedrock aquifer as the shallow overburden soils are not typically used for potable water supply. Additional details on each water well can be seen below in **Table 1**.

Table 1. Water Well Records

Well ID	Date Completed	Depth (m)	Static Water Level (mbgs)	Well Yield (L/min)	Use
2506078	1977-04-11	16.2	0.3	15.2	Domestic
2503859	1972-06-19	12.2	-	7.6	Domestic
2515765	2003-08-21	21.3	3.0	19.0	Domestic
2512221	1993-05-28	22.3	2.4	19.0	Domestic
2510535	1989-08-01	34.4	12.2	11.4	Not Used
2510536	1989-07-31	18.9	11.3	7.6	Not Used
2509114	1987-08-14	21.0	0.9	19.0	Domestic

Well ID	Date Completed	Depth (m)	Static Water Level (mbgs)	Well Yield (L/min)	Use
2510096	1989-06-15	49.7	24.1	11.4	Domestic
2502062	1947-10-30	80.2	3.7	11.4	Livestock
2505699	1976-06-08	10.7	-	15.2	Domestic
2512739	1994-12-01	42.7	4.0	19.0	Domestic

2.5 Source Water Protection

The site located in the Saugeen, Grey Sauble, Northern Bruce Peninsula Source Protection Region. The Source Water Protection Plan identifies three main regulatory factors under the *Clean Water Act (2006)* relating to local hydrogeology to consider for site development: Significant Groundwater Recharge Areas (SGRAs), Highly Vulnerable Aquifers (HVAs), and Wellhead Protection Areas (WHPAs).

Based on available MECP Source Protection information mapping, the south west portion of the site within the woodlands and the north east portion of the site along the property boundary is situated within a SGRA with a score of 2, which is considered low (**Figure 6**). An SGRA area is an area where it is desirable to regulate or monitor drinking water threats that may affects the recharge of an aquifer. No HVA or WHPA were found near the study area.

It is also noted that the site is situated within an Intake Protection Zone 2 (IPZ-2) for the Meaford water intake from Georgian Bay. The IPZ-2 acts as a secondary protective zone that is usually upstream of IPZ-1. This zone is around a surface water body that may contribute water to an intake within a 2-hour time of travel, which is considered to be enough time for plant operators to respond to a spill.

3. Site Conditions

3.1 Drilling and Installation of Monitoring Wells

As part of the Palmer geotechnical investigation, six (6) boreholes (BHM1-1 to BHM1-6) were drilled between April 2, 2020 and April 13, 2020. The boreholes were drilled using solid stem augers, to depths ranging from 3.1 metres below ground surface (mbgs) to 8.1 mbgs. Five (5) of the boreholes were completed as monitoring wells in accordance with Ontario Regulation 903. The monitoring wells were made of 5.1 cm (2 inch) diameter schedule 40 polyvinyl chloride (PVC) pipe, with either a 1.5 m (5 foot) or 3.0 m (10 foot) screened interval, depending on the soil composition. Borehole and monitoring well locations are shown on **Appendix A** and borehole logs are provided in **Appendix B**. **Table 2** provides a summary of borehole and monitoring well details.

Table 2. Borehole and Monitoring Well Installation Details

Borehole/ Monitoring Well	Depth (mbgs)	Approx. Screened Interval (mbgs)	Screened Geology
BHM1-1	6.5	2.9 to 6.0	Silty clay till
BHM1-2	3.3	1.2 to 2.7	Silty clay till

Borehole/ Monitoring Well	Depth (mbgs)	Approx. Screened Interval (mbgs)	Screened Geology
BHM1-3	4.0	2.0 to 3.5	Silty clay till
BHM1-4	6.5	2.3 to 5.4	Silty clay till
BHM1-5	8.1	4.6 to 7.7	Clayey silt till
BHM1-6	3.1	n/a – borehole only	n/a – borehole only

3.2 Hydrostratigraphy

Hydrostratigraphic units can be subdivided into two distinct groups based on their ability to allow groundwater movement. An aquifer is classically defined as a layer of soil that is permeable enough to permit a usable supply of water to be extracted. An aquitard is a layer of soil that inhibits groundwater movement due to its low permeability. Shallow groundwater flow within the analysis area is influenced by two (2) key hydrostratigraphic units: Coarse-textured glaciolacustrine deposit and silty clay/clayey silt till.

Coarse-textured glaciolacustrine aquifer deposits were identified in Ontario Geological Survey (OGS) surficial geology mapping as well as within the borehole logs as being present over the far western and eastern portions of the site (**Figure 2**). This deposit was found in BHM1-1 which is located in the south west portion of the site. This unit is comprised primarily of coarse textured soils: sand and silty sand. Generally, this unit has a high permeability, estimated to range from 10^{-4} to 10^{-7} m/s, and therefore forms a thin surficial aquifer that allows horizontal groundwater flow and recharge. The thickness of this unit is expected to range from 0.1 to 2.4 mbgs according to the drilled boreholes. Perched water can be expected to be found in this layer as the till unit below restricts drainage to depth.

Silty clay till aquitard materials can be found at surface over the majority of the site, and below the glaciolacustrine aquifer along the western property boundary. According to surficial geology mapping, the till found in the area is usually a stone poor, carbonate-derived silty to sandy till. However, from the boreholes, a till with higher clay content was found and was determined to have a predominantly silty clay matrix. This unit has a low permeability, estimated to range from 10^{-6} to 10^{-9} m/s, forming an aquitard that inhibits groundwater flow and recharge. The thickness of this unit reached up to 7.4 m in thickness before auger refusal.

3.3 Groundwater Level and Flow

Five (5) 50 mm diameter monitoring wells were installed to monitor stabilized groundwater levels. The stabilized groundwater levels were measured on April 13, April 17, and May 13, 2020. It should be noted that groundwater levels can vary and are subject to seasonal fluctuations in response to weather events. **Table 3** shows the water levels in each monitoring well.

The majority of the site was found to be dry with groundwater only being found in BHM1-1 and BHM1-2, which are situated on the southwest portion of the site within the woodlot and center portion of the site, respectively. Wells BHM1-3 through BHM1-5 were dry at depths ranging from 4.0 to 8.1 mbgs. Over the

majority of the site, runoff of precipitation is expected to dominate over infiltration, and flow overland towards lower lying areas and Centreville Creek.

Based on the water level at BM1-1, the southwest portion of the site is underlain by a thin layer of coarse-textured glaciolacustrine soils and a perched water table forms due to poor drainage through the low permeability silty clay till below. Over this isolated area, water that infiltrates from precipitation or snow melt rapidly percolates through the glaciolacustrine sand and silt at surface and is expected to flow laterally towards the north-northwest in the direction of Centreville Creek, as seen from the groundwater levels at the M2 property. It is understood that the water level found in BHM1-2 is representative of the perched water table within the fill layer above the low permeability silty clay till, and not representative of the groundwater table.

Table 3. Water Levels

Borehole/ Monitoring Well	Water Level (mbgs)		
	April 13, 2020	April 17, 2020	May 13, 2020
BHM1-1	-	0.42	0.51
BHM1-2	Dry @ 3.3	Dry @ 3.3	1.53
BHM1-3	Dry @ 4.0	Dry @ 4.0	Dry @ 4.0
BHM1-4	Dry @ 6.5	Dry @ 6.5	Dry @ 6.5
BHM1-5	-	Dry @ 8.1	Dry @ 8.1

3.4 Hydraulic Conductivity Testing

On April 17, 2020, Palmer personnel conducted in-situ testing of the hydraulic conductivity (K) of the geological material immediately surrounding BHM1-1. BHM1-2 to BHM1-5 were dry and tests could not be completed in these monitoring wells.

A rising-head (RH) test was conducted at BHM1-1. The well was completely purged of water and the recovery was measured. Water levels in the well were recorded for approximately one hour using a datalogger which was set to record at one-second intervals. Manual water-level measurements were also collected during the test to gauge recovery. K-values were calculated from the displacement-time data using the Bouwer-Rice method as modelled by Aqtesolv™ software. The results are provided in **Appendix C**.

The hydraulic conductivity measured at BHM1-1 was calculated to be 2.8×10^{-7} m/s. This value is low for the glaciolacustrine soils found at this location and is expected to be representative of the silty clay till unit. This value is considered low and groundwater seepage from this unit is expected to be minor. Seepage within the glaciolacustrine soils above 2.4 mbgs is expected to be significant as these soils will have a higher permeability in the range of 10^{-5} to 10^{-6} m/s.

4. Development Considerations and Potential Effects

4.1 Building Foundations

Overall, the site hosts a relatively deep water table ranging from greater than 3.3 mbgs to greater than 8.1 mbgs, and low permeability soils at surface ($2.8x10^{-7}$ m/s). It is understood that the water level found in BHM1-2 is representative of the perched water and not representative of the groundwater table. These conditions occur within the tableland areas associated with the agricultural fields. No significant constraints to foundation design related to groundwater conditions were identified over the majority of the site based on the results of our borehole drilling program.

The area along the western boundary (as identified by BHM1-1) hosts a shallow perched water table and high permeability soils. Should development occur in this area, the grade should be raised so that basement foundations are at least 1 m above the perched water table. It should be acknowledged that other engineering solutions may be possible to keep building foundations dry. Additional hydrogeological monitoring is recommended should development occur in this area.

4.2 Stormwater Pond

The Stormwater (SWM) Pond, near BHM1-5 location is expected to be approximately 2.5 m deep and founded in the low permeability clayey silt till. This area was found to be dry at 8.1 mbgs. Clay liners are generally required for SWM Pond founded on soils with a permeability of greater than $1x10^{-8}$ m/s. Additional hydraulic testing should be completed in this area to confirm the need for a liner.

4.3 Groundwater Recharge and Discharge

As identified under Source Water Protection, the portions of the site underlain by glaciofluvial deposits along the western and eastern boundaries are considered to be within an SGRA. The remaining portions of the site are unconstrained based on Source Water Protection groundwater policies. Based on our preliminary assessment, it does not appear that the site provides a significant recharge function to bedrock aquifers thereby limited the importance of infiltration on the site. Development within the areas identified as a SGRA generally requires that pre-to-post development infiltration is maintained to the best extent practical.

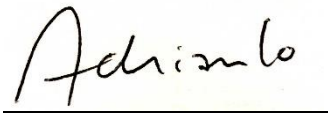
4.4 Local Water Wells

The MECP water well records show 11 water wells records within a 500 m radius of the site, however it is expected that there are more than found in the database. All the wells identified obtain water from the bedrock aquifer and therefore, would not be expected to be impacted by the proposed development.

5. Closure

This report was prepared, reviewed and approved by the undersigned:

Prepared By:



Adrian Lo, B.Sc., G.I.T.
Environmental Scientist (Hydrogeology)

Approved By:

Jason Cole, M.Sc., P.Geo.
Principal, Senior Hydrogeologist

6. References

Armstrong, D.K., and Dodge, J.E.P. 2007. Paleozoic Geology Map of Southern Ontario. Ontario Geological Survey, Miscellaneous Release – Data 219.

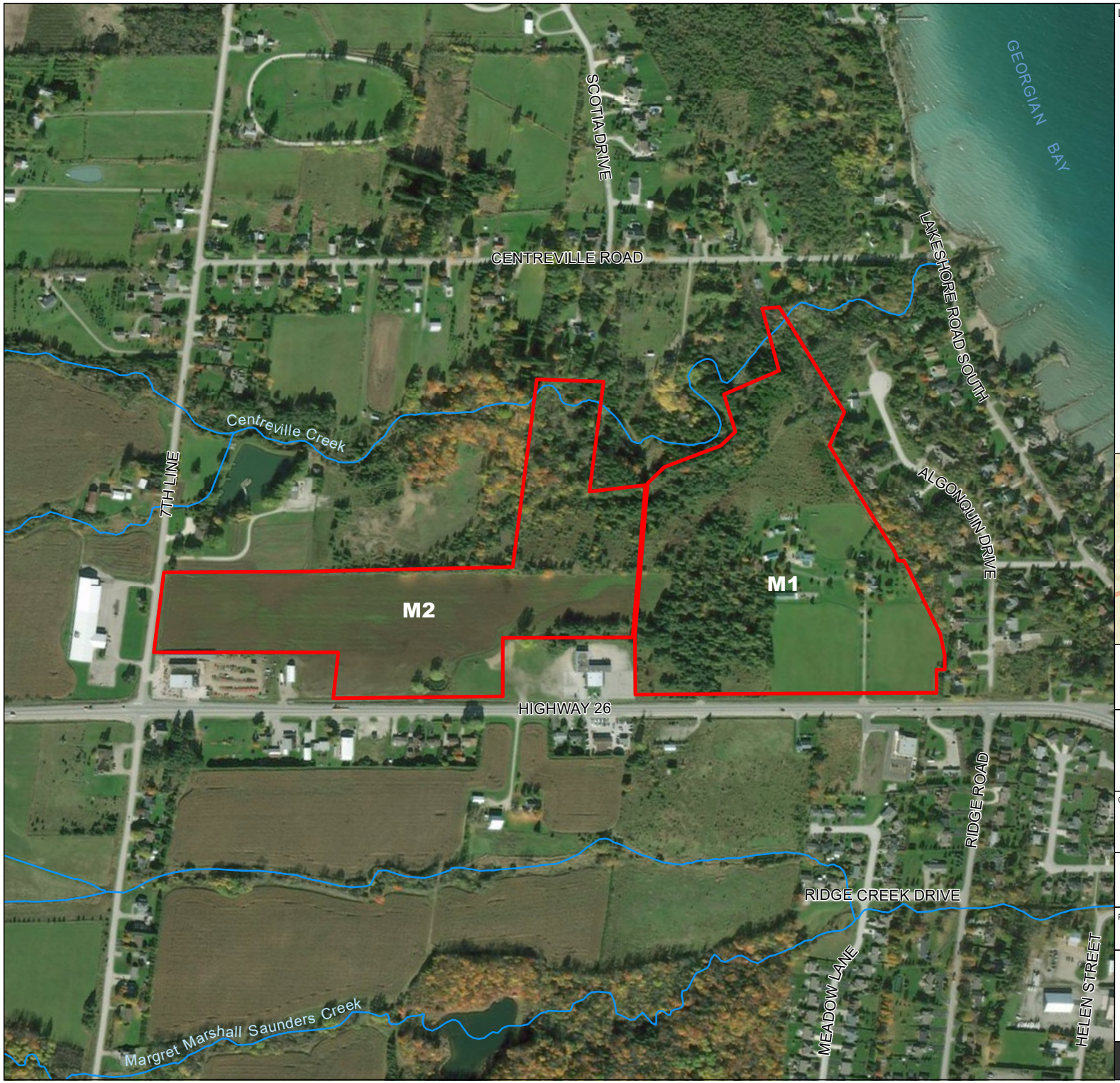
Chapman, L.J. and D.F. Putnam. 1984. Physiography of Southern Ontario. Ontario Geological Survey, Special Volume 2: 270 p.

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

Ministry of the Environment and Energy (MOEE), 1995. Technical Information Requirements of Land Development Applications.

The Ontario Geological Survey. 2003. Surficial Geology of Southern Ontario

Figures



LEGEND:

- Subject Properties
- Watercourse (OHN)

Imagery provided by Esri basemap service (DigitalGlobe)

Key Map

0 100 200 300

metres

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DATE:	Mar 25, 2020	SCALE:	1:7500
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT:

LC Development Group
(LCDG Inc.)

PREPARED BY:

Palmer™

PROJECT:

206105 Hwy 26 (Meaford)
Environmental Review

Site Map

Figure 1

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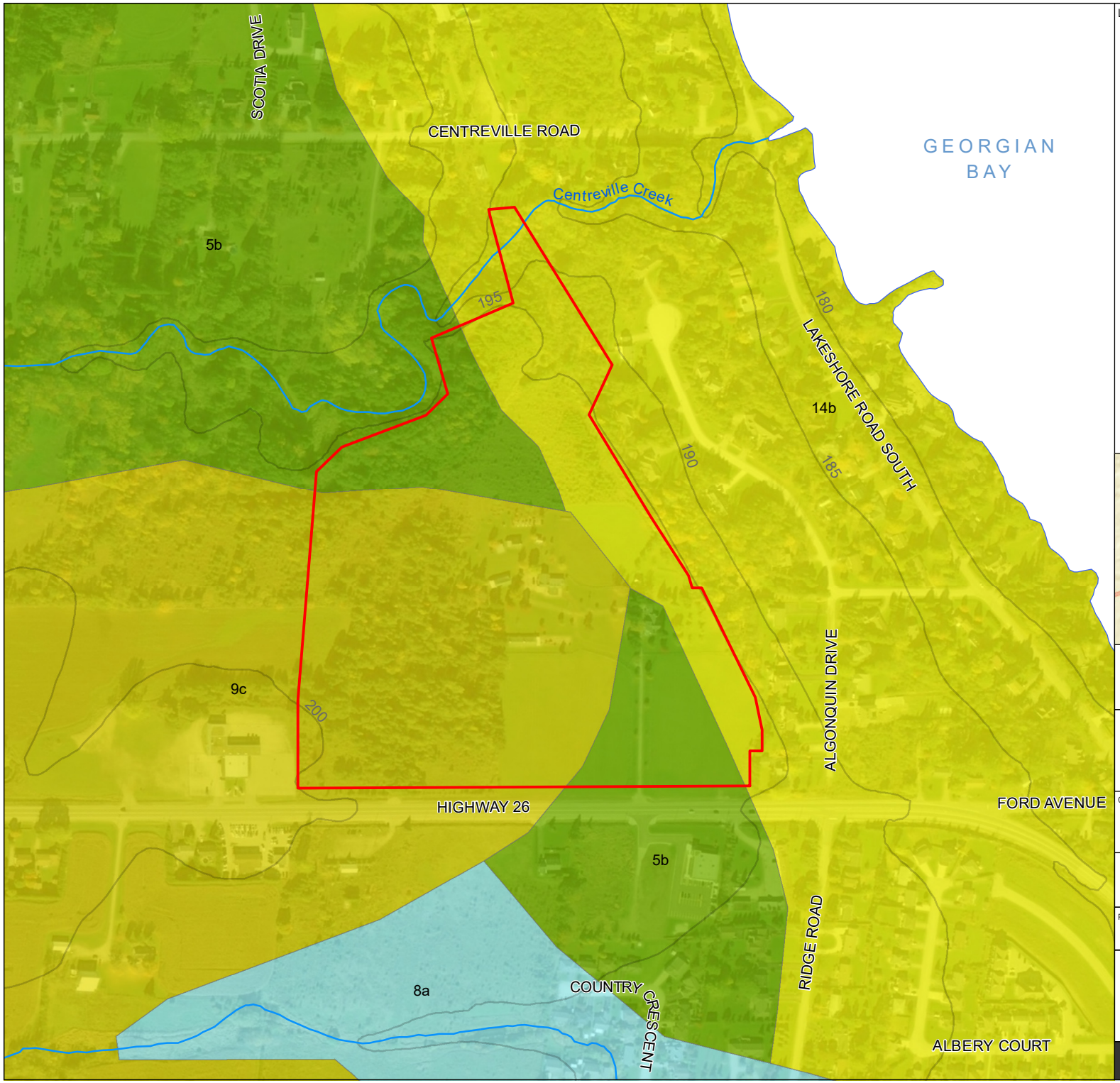

LEGEND:

- Subject Property
- Watercourse (OHN)
- Contour (5 m)

Surficial Geology[1]

- 5b — Stone-poor, carbonate-derived silty to sandy till
- 8a — Massive-well laminated glaciolacustrine deposits: clay and silt, minor very fine sand
- 9c — Foreshore-basinal glaciolacustrine deposits: sand and silt
- 14b — Littoral-foreshore lacustrine deposits: sand and gravel

1 - Source: Ontario Geological Survey 2010 (Mapped at 1:50,000). Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release- Data 128 - Revised

Imagery provided by Esri basemap service (DigitalGlobe)

Key Map

0 50 100 150 200

metres

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DATE:	Mar 25, 2020	SCALE:	1:5000
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT:

LC Development Group
(LCDG Inc.)

PREPARED BY:

Palmer

PROJECT:

206105 Hwy 26 (Meaford)
Environmental Review

Surficial Geology

Figure 2

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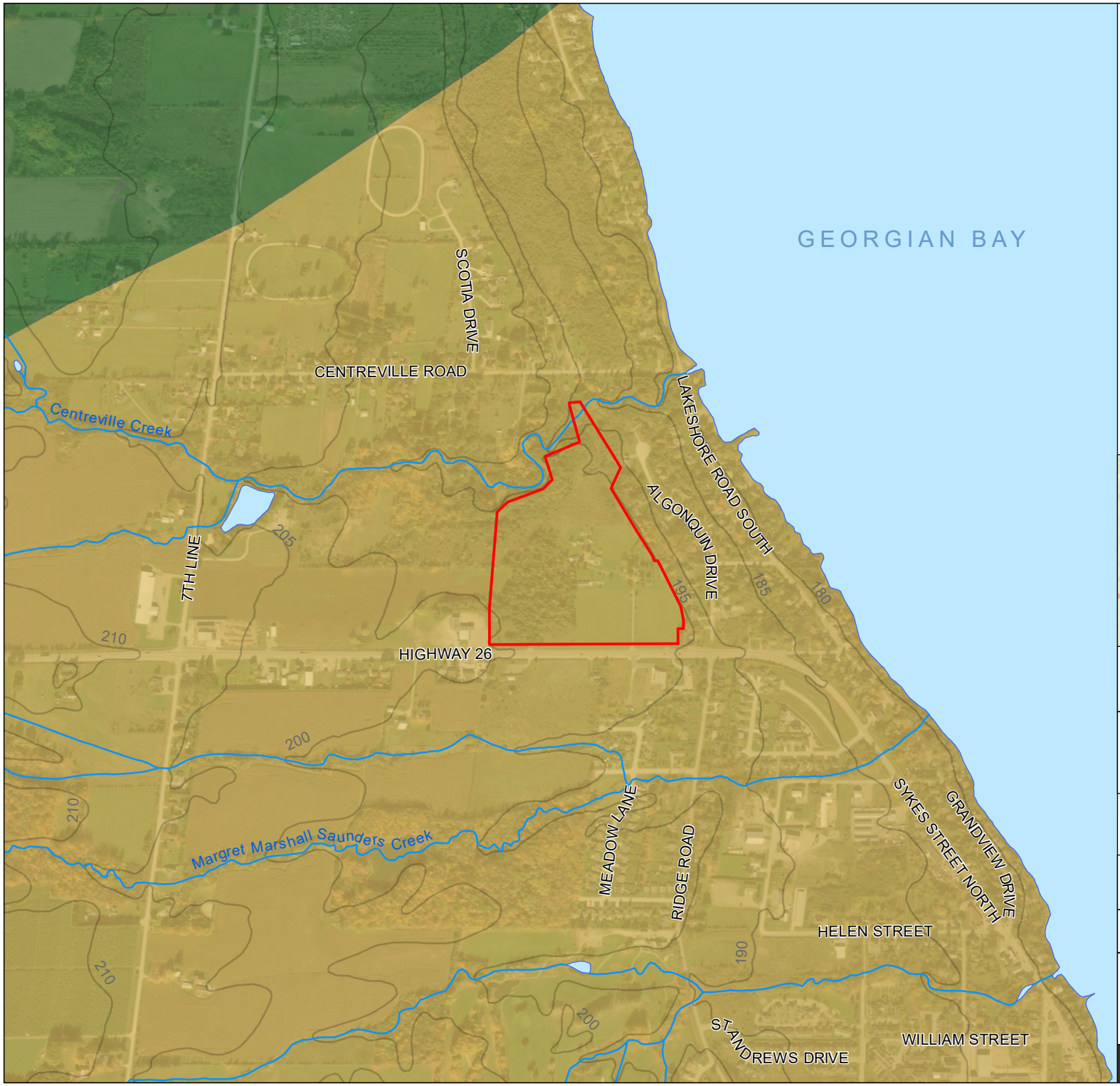

LEGEND:

- Subject Property
- Watercourse (OHN)
- Contour (5 m)

Physiographic Region

- Bighead Valley
- Cape Rich Steps

1 - Source: Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 228.

Imagery provided by Esri basemap service (DigitalGlobe)

0 100 200 300 400

metres

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DATE:	Mar 25, 2020	SCALE:	1:12000
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT:

LC Development Group
(LCDG Inc.)

PREPARED BY:

Palmer™

PROJECT:

206105 Hwy 26 (Meaford)
Environmental Review

Physiographic Region

Figure 3

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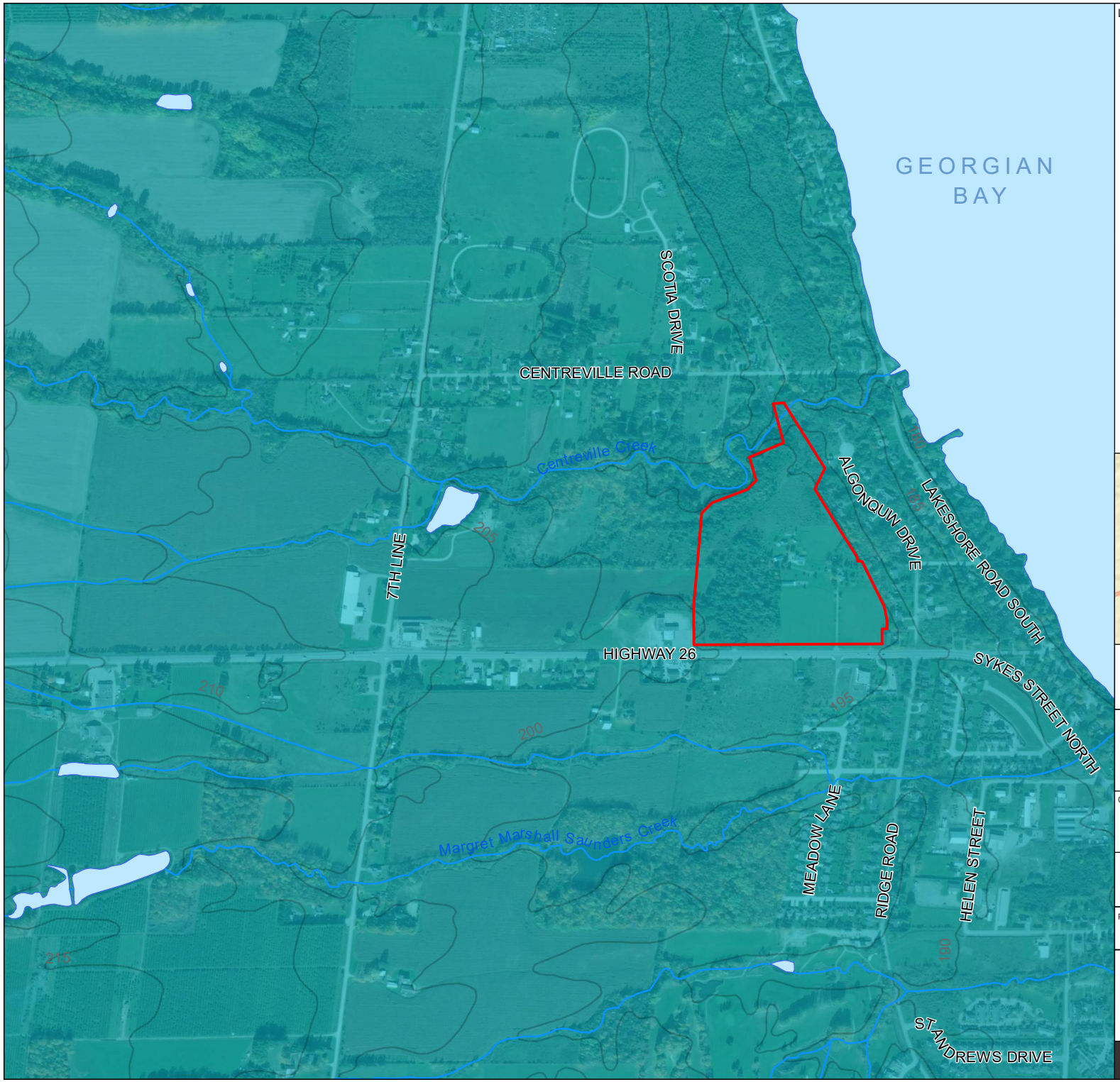

LEGEND:

- Subject Property
- Watercourse (OHN)
- Contour (5 m)

Bedrock Geology[1]

55b	*Shale, limestone, dolostone, siltstone. Georgian Bay Formation; Blue Mountain Formation; Billings Formation; Collingwood Member; Eastview Member*

1. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release –Data 126 - Revision 1.

Imagery provided by Esri basemap service (DigitalGlobe)

Key Map

0 100 200 300 400

metres

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DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT:

LC Development Group
(LCDG Inc.)

PREPARED BY:

Palmer

PROJECT:

206105 Hwy 26 (Meaford)
Environmental Review

Bedrock Geology

Figure 4

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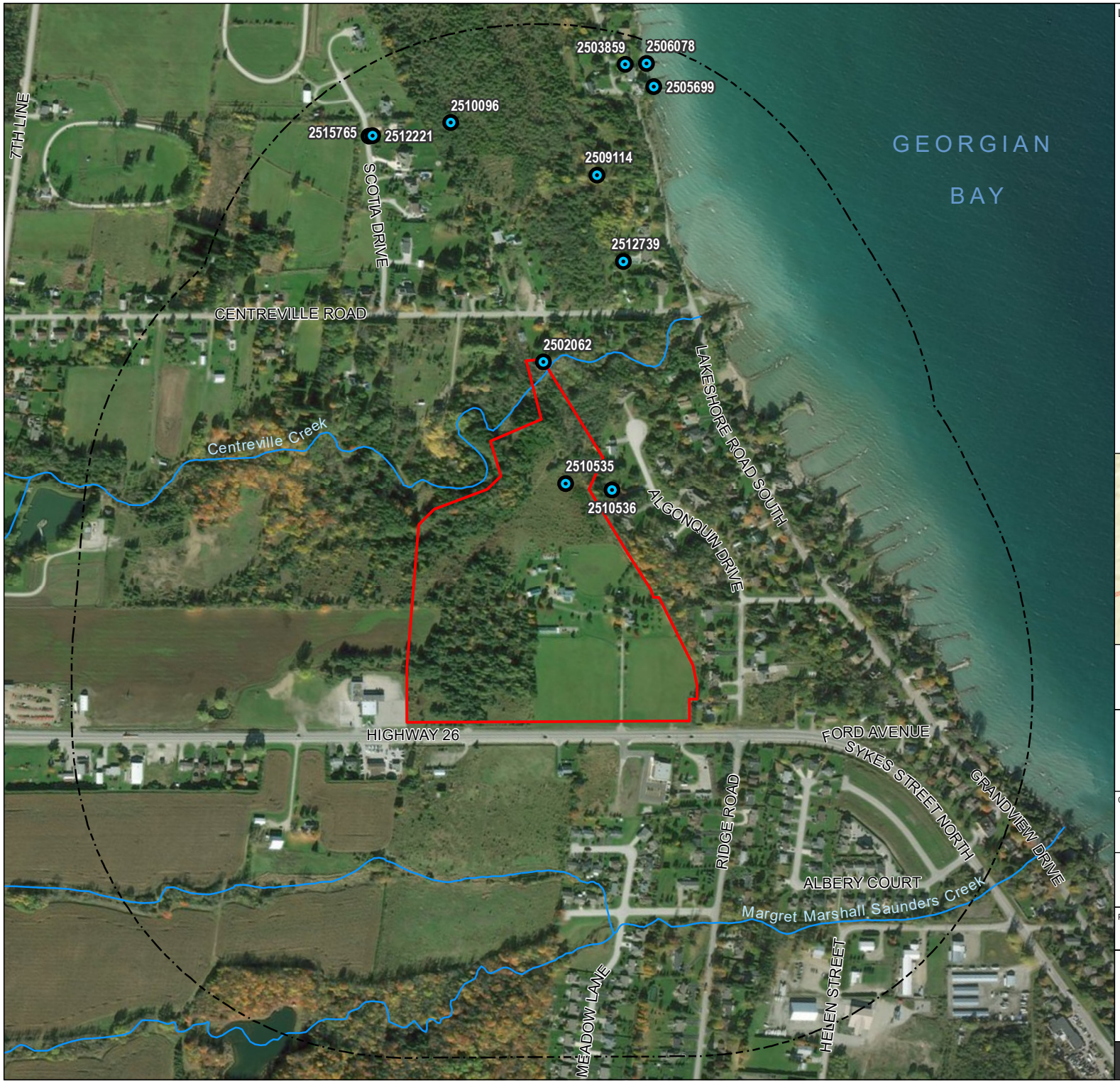

LEGEND:

- Subject Property
- 500 m Buffer
- Watercourse (OHN)
- MECP Water Well

Water well locations and summaries provided by the Water Well Information System (WWIS) - Ministry of the Environment, Conservation and Parks.

Imagery provided by Esri basemap service (DigitalGlobe)

0 100 200 300

metres

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DATE:	Mar 25, 2020	SCALE:	1:8000
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT:

LC Development Group
(LCDG Inc.)

PREPARED BY:

Palmer™

PROJECT:

206105 Hwy 26 (Meaford)
Environmental Review

MECP Water Wells in a 500 m Radius

Figure 5

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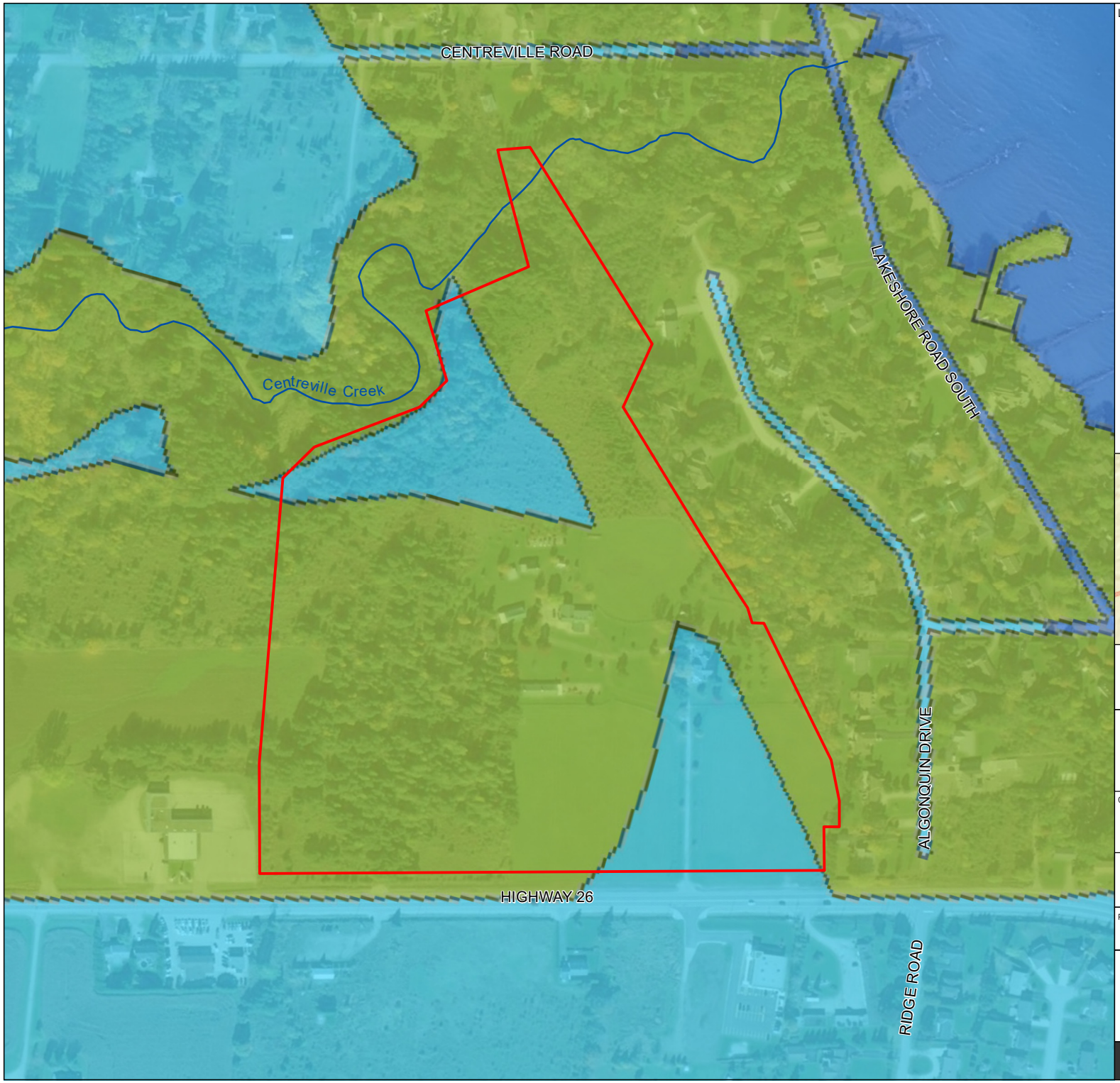


LEGEND:

- Subject Property
- Watercourse (OHN)
- Intake Protection Zone 1
- Intake Protection Zone 2
- Significant Groundwater Recharge Area (Score = 2)

Data aquired from Ontario Source Protection Information Atlas - Ministry of Environment, Conservation and Parks.

Imagery provided by Esri basemap service (DigitalGlobe)

0 50 100 150 200

metres

PROJECT NO.	2001801	REVISION:	1-1
DATE:	Mar 25, 2020	SCALE:	1:4000
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT:

LC Development Group
(LCDG Inc.)

PREPARED BY: Palmer

PROJECT: 206105 Hwy 26 (Meaford)
Environmental Review

Source Water Protection

Figure 6

Document Path: C:\Egnyte\Shared\Projects\Active\20018 - LC Development Group - LCDG INC\2001801 - 206105 Highway 26 (M1 & M2), Meaford\Mapping\Figures\5_ArcGIS\HydroG - M1\1603340_6-1_Source Water Protection.mxd

Appendices

Appendix A. Borehole Locations (Palmer, 2020)

Appendix B. Borehole Logs (Palmer, 2020)

Appendix C. Rising Head Test (Palmer, 2020)


BH-M1-5
BH-M1-2
BH-M1-3
BH-M1-4
BH-M1-6
BH-M1-1
Algonquin Dr
Ridge Rd
Abery
172 m
Image © 2020 Maxar Technologies

Palmer

LOG OF BOREHOLE BHM1-1

PROJECT: Geotechnical Investigation, Phase 2 ESA, M1

CLIENT: LC Development Group

PROJECT LOCATION: Meaford, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Continuous Spoon/Solid Stem Augers

Diameter: 155 mm

Date: Apr-13-2020

REF. NO.: 2001801

ENCL NO.: 1

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface							
0.0	**TOPSOIL:** 250 mm					Concrete		
0.3	**FILL:** clayey silt, some sand, trace gravel, some organics, trace rootlets, contains layers of sand, dark brown to brown, moist, firm		1	SS	5	W. L. 0.4 mBGL Apr 17, 2020		
0.6			2A	SS		W. L. 0.5 mBGL May 13, 2020		Spoon wet
0.8	**SAND:** some silt, trace gravel, brown, wet, compact		2B	SS	27			
	CLAYEY SILT TILL: some sand, trace gravel, contains seams of sand, contains cobbles, brown, moist, very stiff to hard		3	SS	46	Holeplug		
1.8	**SILTY SAND:** trace clay, trace gravel, brown, wet, compact		4	SS	14			Auger grinding
2.4	**SILTY CLAY TILL:** some sand, trace gravel, contains cobbles and boulders, brown, moist, hard		5	SS	35			
			6	SS	39			
						Sand		Auger grinding
						Screen		Auger grinding
			7	SS	90/ 230mm			
								Auger grinding from 4.9m to 5.8m
	contains layers of sand		8	SS	91/ 280mm	Natural Pack		
6.5	**END OF BOREHOLE** 1. Borehole caved to 5.9 m below ground surface (mBGS) upon completion of drilling. 2. Water was at 0.9 mBGS upon completion of drilling. 3. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 4. Water Level Readings: Date W. L. Depth (mBGS) April 17, 2020 0.42 May 13, 2020 0.51							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BHM1-2

PROJECT: Geotechnical Investigation, Phase 2 ESA, M1

CLIENT: LC Development Group

PROJECT LOCATION: Meaford, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Continuous Spoon/Solid Stem Augers

Diameter: 155 mm

Date: Apr-02-2020

REF. NO.: 2001801

ENCL NO.: 2

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface						
0.0	**CONCRETE:** 180 mm					Concrete	
0.2	**FILL:** sand and gravel, trace clay, trace silt, trace rootlets, trace orgaincs, dark brown to brown, wet, loose	1	SS	8			
0.3						Holeplug	
0.8	**FILL:** clayey silt, some sand, trace organics, contains cobbles, brown, moist, firm to very stiff	2	SS	25			
1	**SILTY CLAY TILL:** some sand, trace gravel, contains seams of sand, contains cobbles and boulders, brown, moist, very stiff to hard	3	SS	55		W. L. 1.5 mBGL May 13, 2020	
2		4	SS	59		Screen	Auger grinding
		5	SS	33			
3						Natural Pack	
		6	SS	50/ 100mm			Auger grinding and spoon bouncing
3.3	**END OF BOREHOLE DUE TO AUGER AND SPOON REFUSAL** 1. Borehole caved to 2.7 mBGS upon completion of drilling 2. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 3. Water Level Readings: Date W. L. Depth (mBGS) April 17, 2020 No GW Accu. May 13, 2020 1.53						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BHM1-3

PROJECT: Geotechnical Investigation, Phase 2 ESA, M1

CLIENT: LC Development Group

PROJECT LOCATION: Meaford, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Continuous Spoon/Solid Stem Augers

Diameter: 155 mm

Date: Apr-02-2020

REF. NO.: 2001801

ENCL NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface						
0.0	**CONCRETE:** 180 mm					Concrete	
0.2	**FILL:** sand and gravel, trace clay, trace silt, brown, wet, compact	1	SS	19			
0.3	**SILTY CLAY TILL:** some sand, trace gravel, contains pockets and seams of sand, contains cobbles and boulders, brown to grey, moist, very stiff to hard	2	SS	40		Holeplug	
		3	SS	19			
		4	SS	51			Auger grinding
		5	SS	57		Sand / Screen	
	grey below 3.1m	6	SS	88/ 250mm			Auger grinding
						Natural Pack	
4.0	**END OF BOREHOLE DUE TO AUGER AND SPOON REFUSAL** 1. Borehole caved to 3.5 mBGS upon completion of drilling. 2. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 3. Water Level Readings: Date W. L. Depth (mBGS) April 17, 2020 No GW Accu. May 13, 2020 No GW Accu.	7	SS	50/ Initial 50mm			Auger grinding and spoon bouncing

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BHM1-4

PROJECT: Geotechnical Investigation, Phase 2 ESA, M1

CLIENT: LC Development Group

PROJECT LOCATION: Meaford, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Continuous Spoon/Solid Stem Augers

Diameter: 155 mm

Date: Apr-02-2020

REF. NO.: 2001801

ENCL NO.: 4

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS / 0.3 m "N"	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface					
0.0	**CONCRETE:** 90 mm				Concrete	
0.1	**FILL:** sand, some gravel, trace silt, trace organics, dark brown to brown, wet, loose	1	SS	10		
0.5						
0.6	**FILL:** clayey silt, trace sand, trace gravel, some organics, trace rootlets, dark brown to brown, moist, stiff	2	SS	35		Spoon wet
	SILTY SAND: trace clay, trace gravel, brown, wet, loose	3	SS	49	Holeplug	
	SILTY CLAY TILL: some sand to sandy, trace to some gravel, contains pockets and layers of sand, contains cobbles and boulders, brown, moist, very stiff to hard	4	SS	17		
		5	SS	30		
		6	SS	27		
					Sand	
					Screen	
						Auger grinding
		7	SS	68/ 280mm		13 21 43 23
						Auger grinding
						Auger grinding
					Natural Pack	
		8	SS	95/ 280mm		
6.5	**END OF BOREHOLE**					

1. Borehole caved to 5.3 mBGS upon completion of drilling.
2. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole.
3. Water Level Readings:

Date	W. L. Depth (mBGS)
April 17, 2020	No GW Accu.
May 13, 2020	No GW Accu.

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BHM1-5

PROJECT: Geotechnical Investigation, Phase 2 ESA, M1

CLIENT: LC Development Group

PROJECT LOCATION: Meaford, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Solid Stem Augers

Diameter: 155 mm

Date: Apr-13-2020

REF. NO.: 2001801

ENCL NO.: 5

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS "N" / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface						
0.0	**TOPSOIL:** 200 mm					Concrete	
0.2	**FILL:** silty clay, trace sand, trace gravel, some rootlets, some organics, contains pockets of sand, dark brown to brown, moist, firm	1	SS	5			
0.7	**CLAYEY SILT TILL TO SILTY CLAY TILL:** some sand to sandy, trace gravel, contains seams and layers of sand, contains cobbles and boulders, brown, moist, hard	2	SS	57			Auger grinding 5 24 53 18
		3	SS	87			
		4	SS	82		Holeplug	Auger grinding
		5	SS	74			
		6	SS	60			Auger grinding
		7	SS	70		Sand Screen	Auger grinding
		8	SS	89/ 280mm		Natural Pack	Auger grinding
8.1	**END OF BOREHOLE DUE TO AUGER AND SPOON REFUSAL** 1. Borehole was open upon completion of drilling. 2. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 3. Water Level Readings: Date W. L. Depth (mBGS) April 17, 2020 No GW Accu. May 13, 2020 No GW Accu.						Auger grinding and spoon bouncing

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BHM1-6

PROJECT: Geotechnical Investigation, Phase 2 ESA, M1

CLIENT: LC Development Group

PROJECT LOCATION: Meaford, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Solid Stem Augers

Diameter: 155 mm

Date: Apr-13-2020

REF. NO.: 2001801

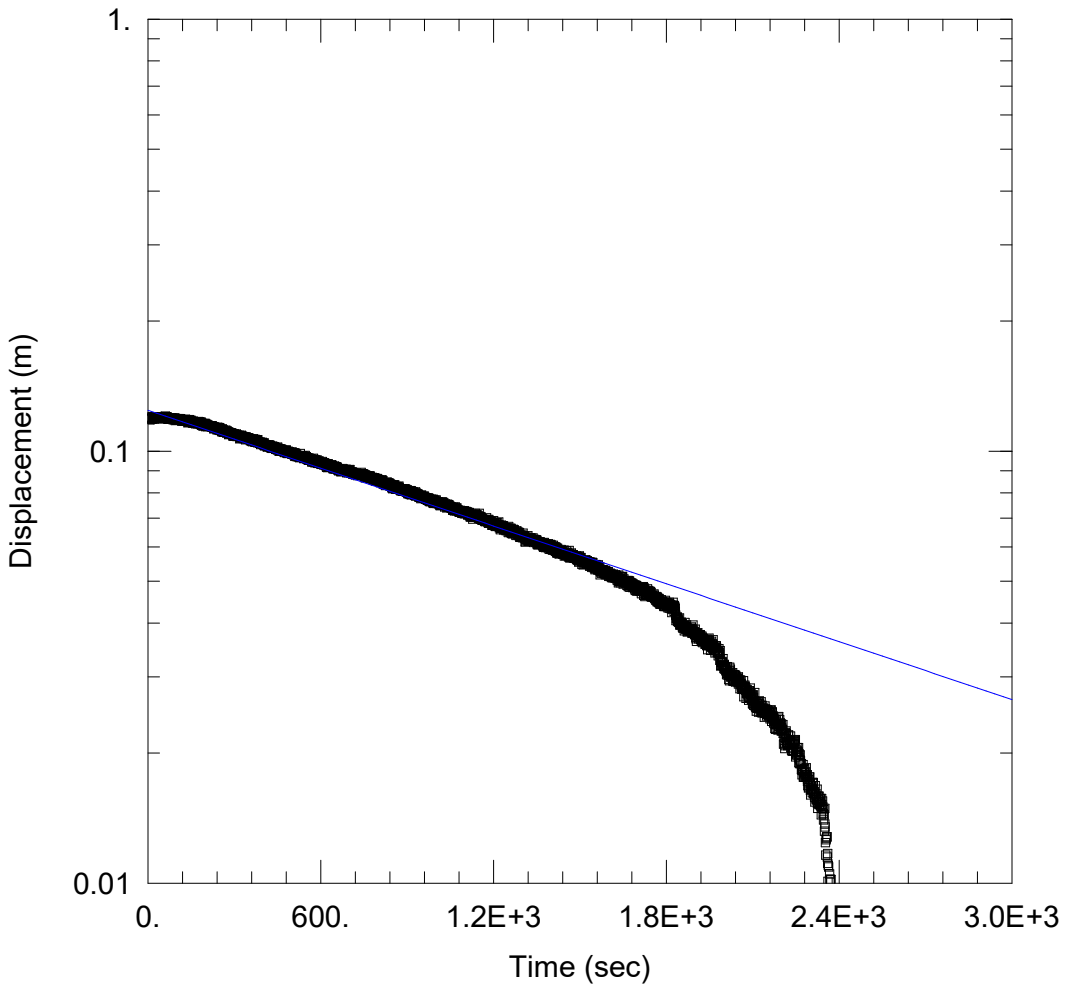
ENCL NO.: 6

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface										
0.0	**TOPSOIL:** 300 mm										
0.3	**FILL:** clayey silt, some sand, trace gravel, some organics, trace rootlets, contains pockets of sand, contains cobbles, dark brown to brown, wet, soft to stiff		1	SS	4						
1			2a	SS							
1.1	**CLAYEY SILT TILL TO SILTY CLAY TILL:** some sand, trace gravel, contains seams of sand, contains cobbles and boulders, brown, moist, stiff to hard		2B	SS	12						
2			3	SS	44						Spoon wet
			4	SS	50/ 125mm						Auger grinding
3											Auger grinding
3.1	contains rock fragments **END OF BOREHOLE DUE TO AUGER AND SPOON REFUSAL** 1. Borehole was open upon completion of drilling. 2. Water was at 2.7 mBGS upon completion of drilling.		5	SS	50/ Initial 50mm						Auger grinding and spoon bouncing

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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



WELL TEST ANALYSIS

Data Set: C:\Users\Adrian\Downloads\BHM1-1 Rising Head Test_JC (1).aqt
Date: 05/04/20 Time: 10:57:35

PROJECT INFORMATION

Company: Palmer
Client: LCDG Inc.
Project: 2001801
Location: Meaford
Test Well: BHM1-1
Test Date: April 17, 2020

AQUIFER DATA

Saturated Thickness: 5.6 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BHM1-1)

Initial Displacement: 0.12 m
Total Well Penetration Depth: 6. m
Casing Radius: 0.025 m
Static Water Column Height: 5.6 m
Screen Length: 3. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.802E-7 m/sec
y0 = 0.1243 m