TATHAM ENGINEERING

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412 Miller Street

HYDROGEOLOGICAL ASSESSMENT

Harry Littler

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Dec 20, 2023
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Issue	Date	Description
1	December 20, 2023	Final Report

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1 Introduction

Tatham Engineering Limited (Tatham) has been retained by Harry Littler (the client) to complete a Hydrogeological Assessment for the proposed residential subdivision development located at 412 Miller Street in Meaford, Ontario, hereafter referred to as the 'site'.

The site is irregular in shape, located on the north side of Miller Street, to the east of Gardiner Street and to the west of Pearson Street. It is bound by Miller Street (Grey Road 12) to the south and by existing residential properties to the north, east and west. The site is located in a predominantly residential and agricultural area in the Meaford settlement area. The site is comprised of a cash crop farm spanning approximately 7 hectares (17.3 acres) and contains a single-detached dwelling as well as two accessory barns located in the southeastern corner and middle of the site. A site location plan is enclosed as Figure 1.

We understand the proposed development (as per Travis & Associates Draft Plan, dated May 29, 2023) includes 18 single detached residential lots, 46 semi detached lots, 26 freehold townhouse units in four blocks, a condominium block with 73 units, stormwater management block, open space block, an environmental protection block and internal roadways. The residential lots will be municipally serviced for water and sewage.

A geotechnical investigation was carried out concurrently by Green Geotechnical Ltd. (Green) and will be reported separately.

1.1 PURPOSE AND SCOPE OF WORK

The main objectives of the Hydrogeological Assessment were to:

- Establish local and regional geology and hydrogeology.
- Determine potential construction dewatering requirements and provide an assessment of anticipated construction dewatering flow rates for a generic constriction scenario.
- Assess groundwater quality and compare the results to the Provincial Water Quality Objectives (PWQO) and Ontario Regulation 153/04, as amended (O.Reg. 153/04).
- Qualitatively assess the potential impacts to the nearby structures, water bodies and water uses, if any, and comment on future regulatory agency involvement.
- Establish and pre and post construction water balance.
- Prepare a Hydrogeological Assessment report.

To achieve the above objectives, Tatham proposed the following scope of work:

- Complete a desktop review of pertinent geological and hydrogeological resources, Ministry of the Environment, Conservation and Parks (MECP) water well records, previous geotechnical reports completed by others, and proposed site plan drawings.
- Visit the site to note existing site conditions, topography, drainage, water features, neighboring land uses, and/or existing water supply or monitoring wells.
- Complete groundwater level monitoring of all accessible and functional wells installed on-site during the 2023 geotechnical investigation completed by Green.
- Perform borehole permeability testing at up to three monitoring wells to determine hydraulic conductivity of the screen soil deposits.
- Determine baseline groundwater quality by collecting and analyzing groundwater from select monitoring wells.
- Evaluate the background information, field and laboratory data to evaluate the construction dewatering requirements.
- Prepare a Hydrogeological Assessment report.

1.2 WATER TAKING – TEMPORARY

Temporary construction dewatering is governed by the Environmental Protection Act, and the following water taking limits and requirements are outlined in O.Reg. 63/16:

- Construction dewatering less than 50,000 L/day: the taking of both groundwater and stormwater does not require a hydrogeological report nor a water taking permit.
- Construction dewatering greater than 50,000 L/day but less than 400,000 L/day: the taking of both groundwater and stormwater does require a hydrogeological report and registration on the Environmental Activity and Sector Registry (EASR).
- Construction dewatering greater than 400,000 L/day: the taking of groundwater and stormwater requires a hydrogeological report and an approved MECP Category 3 Permit-To-Take-Water (PTTW).

This hydrogeological assessment was carried out to assess the potential construction dewatering volumes in order to proceed in accordance with the applicable water taking regulatory requirements and to obtain the applicable water taking permit.

2 Site Setting

The site is irregular in shape, located on the north side of Miller Street, to the east of Gardiner Street and to the west of Pearson Street. It is bound by Miller Street (Grey Road 12) to the south and by existing residential properties to the north, east and west.

The site is located in a predominantly residential and agricultural area in the Meaford settlement area. The site is comprised of a cash crop farm spanning approximately 7 hectares (17.3 acres) and contains a single-detached dwelling as well as two accessory barns located in the southeastern corner and middle of the site.

No bodies of water are present within the site; however, an unnamed tributary is noted to the north of the site between the properties of 425 Nelson Street West and 455 Nelson Street West. This watercourse runs in a north-easterly direction, ultimately draining into Georgian Bay approximately 1,500 m away. This watercourse is within a Grey Sauble Conservation Authority (GSCA) regulated area and is currently zoned as “EP” for environmental protection. The GSCA regulated area and EP zoning extends approximately 25 m into the site toward the north central portion of the site.

2.1 PHYSIOGRAPHY, SURFICIAL AND BEDROCK GEOLOGY

The site lies within the physiographic region known as Bighead Valley comprised of sand plains (Chapman and Putnam, 1984). Ontario Geological Survey (OGS) quaternary geology mapping indicates the site consists primarily of glaciolacustrine deposits comprised of sand, gravelly sand and gravel, and Elma till comprising sandy silt to silt or clayey silt deposits is noted to the southwest of the site.

Based on results of the concurrent geotechnical borehole drilling program, the near surface soils appear to be more consistent with Elma Till consisting of silt to clayey silt with trace to some sand. The details of the geotechnical borehole drilling program are summarized in Section 4.1 and additional details are provided in the separate geotechnical report.

The bedrock at the site primarily consists of Georgian Bay shale and limestone. Bedrock was not encountered during the 2023 geotechnical investigation completed by Green. Based on a review of MECP well records, bedrock is anticipated at depths greater than roughly 42 below ground surface (m bgs).

2.2 TOPOGRAPHY AND DRAINAGE

The topography of the site is relatively flat with a gentle downward slope to the east/northeast. Elevations at the site range from approximately 205.5 m asl along the eastern boundary to approximately 209.5 m asl along the western site boundary.

Under current conditions it is anticipated drainage on site will follow surface topography and flow in one of three directions:

- Towards the east/northeastern to the unnamed tributary located towards the northern limits of the site.
- Towards the east following the natural topography.
- Towards the southeast to a roadside ditch along Miller Street.

Further details regarding the existing drainage conditions on-site are outlined in Tatham's Storm Water Management Report.

2.3 MECP WATER WELL RECORDS

To assess the nature of the groundwater resources as well as the history of the current usage in the area, MECP water well records were reviewed for an approximate 500 m radius surrounding the site. The approximate MECP water well locations are shown on Figure 2, and a summary of the MECP water well records are provided in Appendix A.

A total of eight MECP water well records were reviewed within a 500 m radius of the site. Two well records indicated monitoring well use, five wells indicated domestic water supply use and one record indicated the decommissioning of a dug well.

In general, stratigraphy noted from the shallow monitoring well records indicated layers of sand and gravel, and/or silt and clay. Bedrock was not recorded in any of the MECP well records.

2.4 SOURCE WATER PROTECTION MAPPING

The site is located within the Grey Sauble Source Protection Area (SPA), and a portion of the site is considered to be regulated by the GSCA.

The site is not located within a Municipal Well Head Protection Area (WHPA), Significant Groundwater Recharge Area (SGRA), nor Highly Vulnerable Aquifer (HVA), as shown on Figures 3, 4 and 5. The site does, however, lie within an Intake Protection Zone (IPZ), as shown in Figure 6.

2.5 SITE INSPECTION

A visual site inspection was completed on November 14, 2023, to assess the site's drainage, topography and surface water features.

The site is primarily comprised of agricultural fields surrounded by a forested area to the north and northwest followed by residential properties and residential properties to the east and west. A single residential building is located on the southeast corner of the site and two accessory barns. The site was generally flat with a slight downward slope to the east and northeast. There are no waterbodies within the site, however, there is an unnamed tributary to the north of the site.

2.6 SITE CONDITION STANDARDS

The MECP has developed a set of Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act and O.Reg 153/04, as amended.

The site conditions standards (SCS) consist of nine tables that provide criteria for maximum concentrations of various contaminants, dependent on the site location, land use, soil texture, bedrock depth and the applicable potable or non-potable groundwater condition at the site. Sections 41 and 43.1 of O.Reg 153/04, as amended, were used to evaluate the site conditions.

The conditions of the site are summarized in Table 1, below:

Table 1: Site Condition Standards

CRITERIA	RESULT
Current Property Use	Agricultural or Other Property Use/ Residential Use
Potable vs. Non-Potable Groundwater	Potable
Proximity of Areas of Natural Significance	>30 m
Proximity to a Water Body	<30 m
Shallow Soil Condition	No
Future Land Use	Residential
Applicable Site Condition Standard(s)	Table 8: Generic Site Condition Standards For Use within 30 m of a Water Body in a Potable Ground Water Condition for Residential Property Use Or Table 2: Full Depth Generic Site Condition Standard in a Potable Groundwater Condition for Residential Property Use

3 Procedures and Methodology

3.1 BOREHOLE DRILLING AND MONITORING WELL INSTALLATION

A total of seven boreholes (BH1 through BH7) were advanced during the geotechnical investigation (Green, 2023) to depths of 6.6 m below existing grade. Monitoring wells were installed in five of the borehole locations (BH1, BH2, BH3, BH6, BH7). The borehole/monitoring well locations are shown on Figure 7 and 8.

The geotechnical borehole logs are discussed further in Section 4 and are provided in Appendix B.

3.2 BOREHOLE PERMEABILITY TESTING

Rising head tests were conducted in three monitoring wells on November 14, 2023. Water was purged from the wells using low density polyethylene (LDPE) tubing and a foot valve. Following the removal of three well volumes worth of groundwater or the well going dry, and after at least 95% recovery, the test was initiated. The static water level was measured prior to the start of the test and the change in water level was manually recorded following purging. The change in water level was also recorded on regular intervals for a total of 30 minutes or until 95% recovery. The test was completed to estimate the hydraulic conductivity (K) of the soils at the well screen depth. The plot for drawdown versus time is presented in Appendix C.

3.3 GROUNDWATER SAMPLING

To establish baseline conditions and assess the suitability for discharge of pumped groundwater to surface during potential construction dewatering, groundwater samples were collected from BH2 on November 14, 2023.

The samples were collected using low-flow sampling methods to reduce the sediment content within the samples. Each sample was directly placed into pre-cleaned laboratory-supplied vials and/or bottles with analytical test group specific preservatives. Dedicated nitrile gloves were used during sampling and non-dedicated equipment was sanitized between monitoring wells.

Samples were field filtered for select parameters and submitted for chemical analysis of PWQO Metals as well as O.Reg. 153/04, as amended, Petroleum Hydrocarbons (PHC's) and Volatile Organic Compounds (VOC's). Samples were analyzed by Caduceon Environmental Laboratories, a CALA accredited laboratory located in Barrie, Ontario. Groundwater chemistry results are included in the laboratory Certificates of Analysis, provided in Appendix D.

4 Subsurface Conditions

The geotechnical investigation (Green, 2023) was reviewed for this hydrogeological assessment. The borehole and monitoring well locations are shown on Figure 7 and 8 and draft borehole logs are presented in Appendix B.

4.1 STRATIGRAPHY

In general, the boreholes encountered topsoil overlying silt to clayey silt/silty clay deposits to the termination depths of approximately 6.6 m. A local layer of sandy silt/silty sand was noted in Borehole 1 underlying the topsoil and overlying a silt deposit, and a local fill layer was similarly encountered in Borehole 2 underlying the topsoil and overlying a silt to clayey silt deposit.

4.2 GROUNDWATER

Unstabilized groundwater level measurements and cave measurements were taken upon borehole drilling completion of each borehole by Green. These measurements provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations arising. Upon completion of the boreholes, all boreholes were found open and Boreholes 3 through 5 were found dry, unstabilized groundwater levels of 3.5 to 6.2 m below existing grade (Elevation 202.5 to 204.2 m asl) were noted in the remaining Boreholes.

Monitoring wells were installed in five of seven boreholes to facilitate measurements of stabilized groundwater levels across the site. The monitoring wells were installed with 50-mm PVC riser pipe and a slotted 3.0-meter-long screen. A summary of the monitoring wells installation details is presented in Table 2. Stabilized groundwater level measurements are presented in Table 3.

Table 2: Monitoring Well Installation Details

MONITORING WELL ID	GROUND SURFACE	LOCATION OF SCREEN		STRATA SCREENED
		DEPTH (m)	ELEVATION (m asl)	
BH1	209.0	3.1 – 6.1	202.9 – 205.9	Silt
BH2	207.7	3.1 – 6.1	201.6 – 204.6	Silt to Clayey Silt
BH3	206.5	3.1 – 6.1	200.4 – 203.4	Silt to Clayey Silt
BH6	208.7	3.1 – 6.1	202.6 – 205.6	Silt to Clayey Silt
BH7	208.7	3.1 – 6.1	202.6 – 205.6	Silt to Clayey Silt

Table 3: Groundwater Level Measurements

MONITORING WELL ID	GROUNDWATER DEPTH (m bgs) / ELEVATION (m asl)	
	NOVEMBER 14, 2023	DECEMBER 6, 2023
BH1	0.6 / 208.4	0.6 / 208.4
BH2	0.4 / 207.3	0.3 / 207.4
BH3	0.8 / 205.7	0.6 / 205.9
BH6	0.6 / 208.1	0.4 / 208.3
BH7	1.4 / 207.3	0.3 / 208.4

Stabilized groundwater levels were measured on December 6, 2023, and ranged between 0.3 and 0.6 m bgs (Elevation 205.7 and 208.4 m asl). The inferred groundwater flow direction is toward the northeast, as presented on Figure 9.

4.3 BOREHOLE PERMEABILITY

In-situ borehole permeability testing was carried out on three monitoring wells on November 14, 2023. Rising head tests were conducted and the hydraulic conductivities (K) were calculated using Hvorslev's (1951) solution where the well screen is partially saturated. The semi-log plot for drawdown versus time is provided in Appendix C and summarized in Table 4, below.

Table 4: Hydraulic Conductivity

MONITORING WELL ID	WELL DEPTH (M)	STRATA SCREENED	HYDRAULIC CONDUCTIVITY (M/S)
BH2	6.1	Silt to Clayey Silt	5.7×10^{-8}
BH3	6.1	Silt to Clayey Silt	5.0×10^{-8}
BH7	6.1	Silt to Clayey Silt	2.4×10^{-8}

According to Freeze and Cherry (1979), the typical hydraulic conductivity of the strata investigated are:

- Silt: 10^{-5} m/s to 10^{-9} m/s
- Silty Sand: 10^{-3} m/s to 10^{-7} m/s

The actual measured hydraulic conductivity of the deposits were generally within the expected range; however, for design purposes, the hydraulic conductivity was assumed to be 5.0 x 10^{-8} m/s.

4.4 BASELINE GROUNDWATER CHEMISTRY

To establish baseline conditions and assess the suitability for discharge of pumped groundwater to the surface during potential construction dewatering, one groundwater sample was collected and analyzed for select parameters including: PWQO Metals and O.Reg. 153/04, as amended, PHCs and VOCs. The groundwater samples were obtained from BH2.

The samples were placed into pre-cleaned laboratory supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample collection and handling.

The results of the groundwater chemistry analysis are presented in the laboratory Certificates of Analysis provided in Appendix D and are summarized Table 5, below.

Table 5: Groundwater Chemistry Results

SAMPLE LOCATION	PARAMETERS TESTED	EXCEEDANCES OF PWQO			EXCEEDANCES OF O.REG. 153/04, AS AMENDED, TBL.1 - GW
		Parameter	Concentration (µg/L)	Limit (µg/L)	
BH2	PWQO Metals, O.Reg. 153/04, as amended PHCs and VOCs	Iron	2,340	300	No Exceedances
		Zinc	43	30	No Exceedances

In addition to the above listed exceedances, various parameters including boron, cobalt, copper and lead exceeded the interim PWQO within the unfiltered samples. The above chemical results suggest potential dewatering discharge may not meet the PWQO/Interim PWQO requirements during construction dewatering.

Treatment of dewatering discharge by filtration or sedimentation to reduce the concentration of TSS may reduce the concentration of non-dissolved metals to achieve compliance with PWQO/Interim PWQO guidelines; however, other treatment methods may still be required to reduce the concentration of dissolved analytes during construction.

It is expected during construction dewatering, the pumped water will first be discharged to a silt bag or sedimentation tank, at minimum, before being discharged to the surface and/or nearby waterbodies.

5 Discussion and Analysis

Based on a review of the current conceptual site plans (as of May 29, 2023), it is understood the proposed development will consist of 18 single detached residential units, 46 semi-detached residential units, 26 townhouse units, a storm water management block (approximately 0.45 ha) a condominium block, open space block, environmental protection block and internal roadways. Further, the residential lots will be municipally serviced for water and sewage, and storm sewers.

5.1 TEMPORARY CONSTRUCTION DEWATERING

To calculate the estimated dewatering rate for the proposed on-site construction works, the following assumptions have been made:

- Groundwater is to be drawn down 1.0 m below proposed excavations.
- The water-bearing soils that may be exposed during construction primarily consist of silt to clayey silt with an assumed K-value of 5.0 x 10^{-8} m/s for calculation purposes.
- Saturated soils will be encountered at depths ranging from approximately 0.3 and 0.6 m below existing ground surface (Elevation 205.7 and 208.4 m asl).
- The excavation depths were inferred from typical design depths and are expected to range between 1.5 and 3.0 m below proposed ground surface.
- It is understood the proposed development will require the import of fill, and the proposed grades will be higher than the current grades on-site. As such, the below construction dewatering assessment has been completed utilizing the proposed grades rather than the current grades.
- For calculation purposes the site has been separated into two zones:
  - Site servicing with excavation depths of up to 3.0 m below proposed grades.
  - Stormwater management facility construction with proposed excavation elevation of 209 m asl.
- It is assumed surface water will be managed such that it will not enter the excavation.
- It is assumed all measures will be implemented to ensure the allowable/permitted water taking volumes are not be exceeded. This includes completing the work in smaller sections.

5.1.1 Radius of Influence (ROI)

The Radius of Influence (ROI) for construction dewatering refers to the distance at which the drawdown resulting from pumping becomes negligible. The ROI is calculated using the empirical

Sichardt Equation. The equation is empirical and provides representative flow rates using the steady state flow dewatering equations. The Sichardt Equation is used to provide representative flow calculations; however, it is not precise in determining the actual radius of influence by pumping since during steady state conditions, the ROI of pumping will extend until boundary flow conditions are reached and provide sufficient water inputs to the aquifer, such as recharge and surface water bodies.

The Sichardt Equation is expressed as the following equation:

$$R_0 = 3000(H - h)\sqrt{k}$$

Where:

K = Hydraulic Conductivity (m/s)

H = Static Saturated Head (m)

h = Dynamic Saturated Head (m)

R_0 = Radius of Influence (m)

Based on the Sichardt equation and the design K value, the ROI from the centre of the excavation for radial flow from each zone is tabulated below in Table 6. Calculation details are provided in Appendix E.

Table 6: Radius of Influence

ZONE	DESCRIPTION	ROI (M)
1	Site Servicing (per 100 m of trench)	2
2	Stormwater Management Block	39

5.1.2 Temporary Dewatering Flow Rate

The Dupuit method for linear flow in an unconfined aquifer for a fully penetrating excavation was used within Zone 1, and is expressed as:

$$Q = Kx\frac{H^2 - h^2}{L_o}$$

The Dupuit-Forcheimer method for radial flow in an unconfined aquifer for a fully penetrating excavation was used for Zone 2, and is expressed as:

$$Q = \frac{\pi K(H^2 - {h_w}^2)}{In\frac{R_0}{r_e}} + 2\frac{xK(H^2 - {h_w}^2)}{L}$$

Where:

Q = rate of pumping (m^3/s)

K = hydraulic conductivity (m/s)

H = head beyond the influence of pumping (static groundwater elevation) (m)

h = head above base of aquifer at the excavation (m)

R_0 = Radius of Influence (m)

r_e = Equivalent Radius (m)

X = length of excavation (m)

L = length of excavation (m)

It is anticipated the initial dewatering rate will be higher to remove groundwater from within the overburden formation. As the water level reaches its target elevation, dewatering rates are expected to decrease as the local groundwater storage will have been removed and lessen seepage rates into the excavation.

Using the assumptions and equations outlined above, the estimated dewatering rates were determined and summarized below, in Table 7. Calculation details are provided in Appendix E.

Table 7: Construction Dewatering Estimated Daily Flow Rate

ZONE	DESCRIPTION	CONSTRUCTION DEWATERING FLOW RATE (L/DAY)	CONSTRUCTION DEWATERING FLOW RATE INCLUDING SAFETY FACTOR OF 2	CONSTRUCTION DEWATERING FLOW RATE INCLUDING SAFETY FACTOR OF 2 AND A 10MM RAIN EVENT (L/DAY)
1	Site Servicing (per 100 m of trench)	4,400	8,800	11,800
2	Stormwater Management Block	2,000	4,000	48,890

To account for seasonal fluctuations of the groundwater table and variation in the hydrogeological properties beyond those encountered during this study, a safety factor of 2 was applied. Further to account for surface water infiltration within the excavation footprint, a 10 mm rain event was applied. This rate can be considered a contingency volume subject to the timing and season of construction.

The estimates provided in this report are based on information available at the time of the investigation. If design changes are implemented, additional dewatering estimates will be required to reflect the design changes.

The estimated dewatering volume for the anticipated site servicing per 100 m of trench is 11,800 L/day and for the Stormwater management facility construction is 49,000 L/day. As the estimated dewatering rates are below 50,000 L/day and 400,000 L/day, the registration of an EASR or PTTW are not required.

It is the responsibility of the contractor to ensure dry conditions are maintained within the excavations at all times. If dewatering does exceed the 50,000 L/day volume during construction, a EASR will be required. Dewatering volumes should be closely monitored during construction to ensure the threshold of 50,000 L/day is not exceeded, which may require construction be carried out in smaller sections.

5.2 WATER BALANCE

An evaluation of the anticipated changes in the water balance between pre-development and post-development conditions has been included to quantify the expected changes to water balance across the site with and without mitigation.

Using historical precipitation data from the Thornbury Slama weather station, the pre-development water balance model shows a total of 21,750 m^3 of annual infiltration volume is provided over the site area (7.01 ha). The proposed land-use for the development is residential purposes. The post development impervious area was established in the stormwater management report prepared by Tatham in 2023 and is considered 3.66 ha of impervious area. As such, the post-development water balance assessment shows, without mitigation, infiltration on the site area will decrease by up to 52.2%, corresponding to an annual infiltration reduction of 11,355 m^3. Water balance calculations are included in Appendix F for reference.

5.2.1 Low impact feasibility assessment

In accordance with the typical conservation authority offsetting policy, efforts will be made to mitigate the infiltration deficient post-development including the potential incorporation of Low Impact Development (LID) features.

As discussed in previous sections, the site has shallow soils primarily consisting of silt to clayey silt with groundwater level measurements to date ranging between 0.3 to 0.6 m below existing grade (Elevation 207.6 and 208.4 m asl). Based on the concept grading plan, approximately 1-4 m of fill may be imported to the site prior to construction activities.

The native silt to clayey silt soils are not considered feasible for LID features given the anticipated low permeability of the soils and resulting low infiltration rates. Further, the groundwater levels measured to date do not represent the seasonal high groundwater and may be even higher than already measured shallow levels to date, further prohibiting the implementation of LID features.

However, the imported fill materials may be suitable for LID features provided at least a 1.0 m separation from the base of any proposed LID and the seasonal high groundwater levels could be achieved. If groundwater levels are low enough that LIDs can be accommodated on-site further in-situ infiltration testing (Guelph Permeameter testing) should be carried out in the vicinity of imported fill materials

The sizing of any proposed LID feature would need to be reviewed with the proposed site plan to ensure sufficient offsets from structures on-site are achieved.

Based on the above, LIDs in theory may be considered feasible within imported materials on-site; however, the groundwater, soil conditions, and the proposed site plan may limit the feasibility of LIDs on-site.

6 References

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

Green Geotechnical Ltd., Draft Enclosures. October 2023.

N

NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- ROADS
- WATERCOURSES
- WATERBODY
- WOODED AREA

ORCHARD CREEK
CENTREVILLE CREEK
HIGHWAY 26
SYKES STREET NORTH
GEORGIAN BAY
PETE'S CREEK
MEAFORD
NELSON STREET WEST
PEARSON STREET
BIGHEAD RIVER
SYKES STREET SOUTH
WHITELAW'S CREEK
MEAFORD CEMETARY CREEK
MEAFORD CEMETARY CREEK TRIB
MILLER STREET
PETE'S CREEK
BIGHEAD RIVER TRIB
MEAFORD CREEK
HIGHWAY 26
GREY ROAD 12
PETE'S CREEK
PETE'S CREEK
GREY ROAD 7
WHITELAW'S CREEK TRIB

0 250 500 1,000
METERS

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412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
SITE LOCATION PLAN

DWG. No. **FIG-1**

SCALE: 1:15,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

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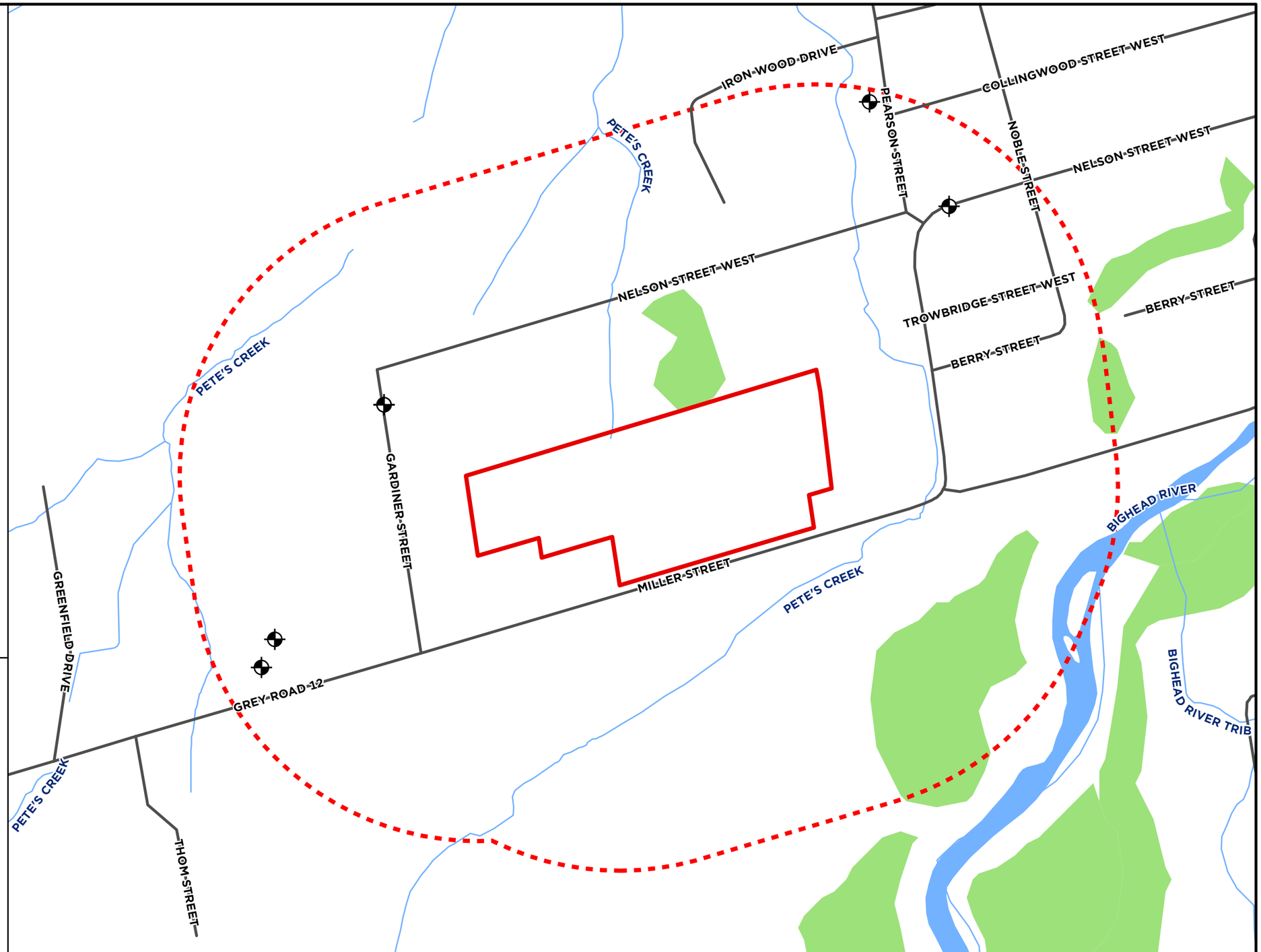
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- SITE BUFFER (500 M)
- MECP WATER WELL LOCATIONS
- ROADS
- WATERCOURSES
- WATERBODY
- WOODED AREA



0 80 160 320 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
MECP WATER WELL LOCATIONS

DWG. No. **FIG-2**

SCALE: 1:5,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

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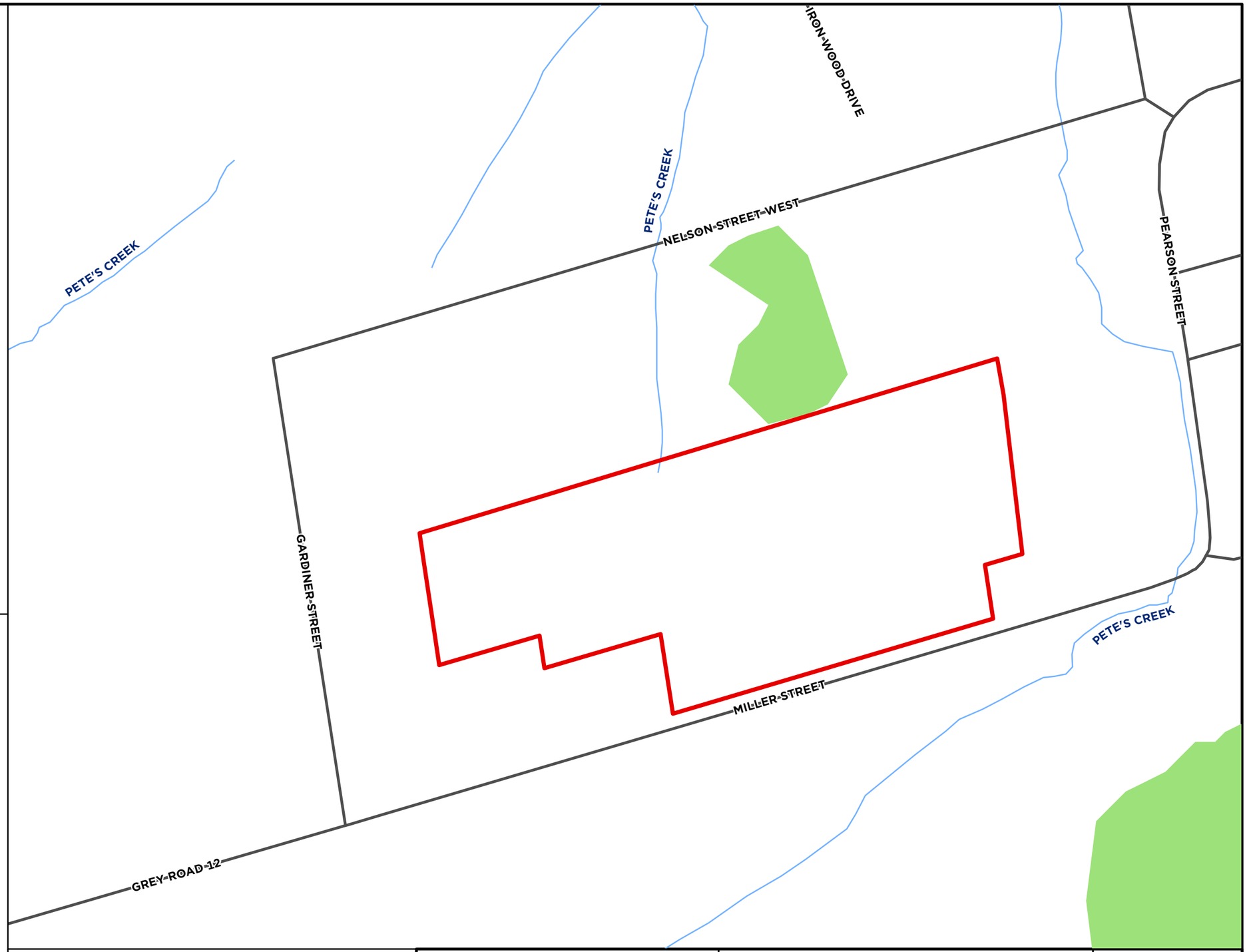
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- WELLHEAD PROTECTION AREA (LSRCA 2022)
- ZONE
  - A
  - B
  - C
  - C1
  - D
- ROADS
- WATERCOURSES
- WATERBODY
- WOODED AREA



0 50 100 200 METERS

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412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
WELL HEAD PROTECTION AREA

DWG. No. **FIG-3**

SCALE: 1:3,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

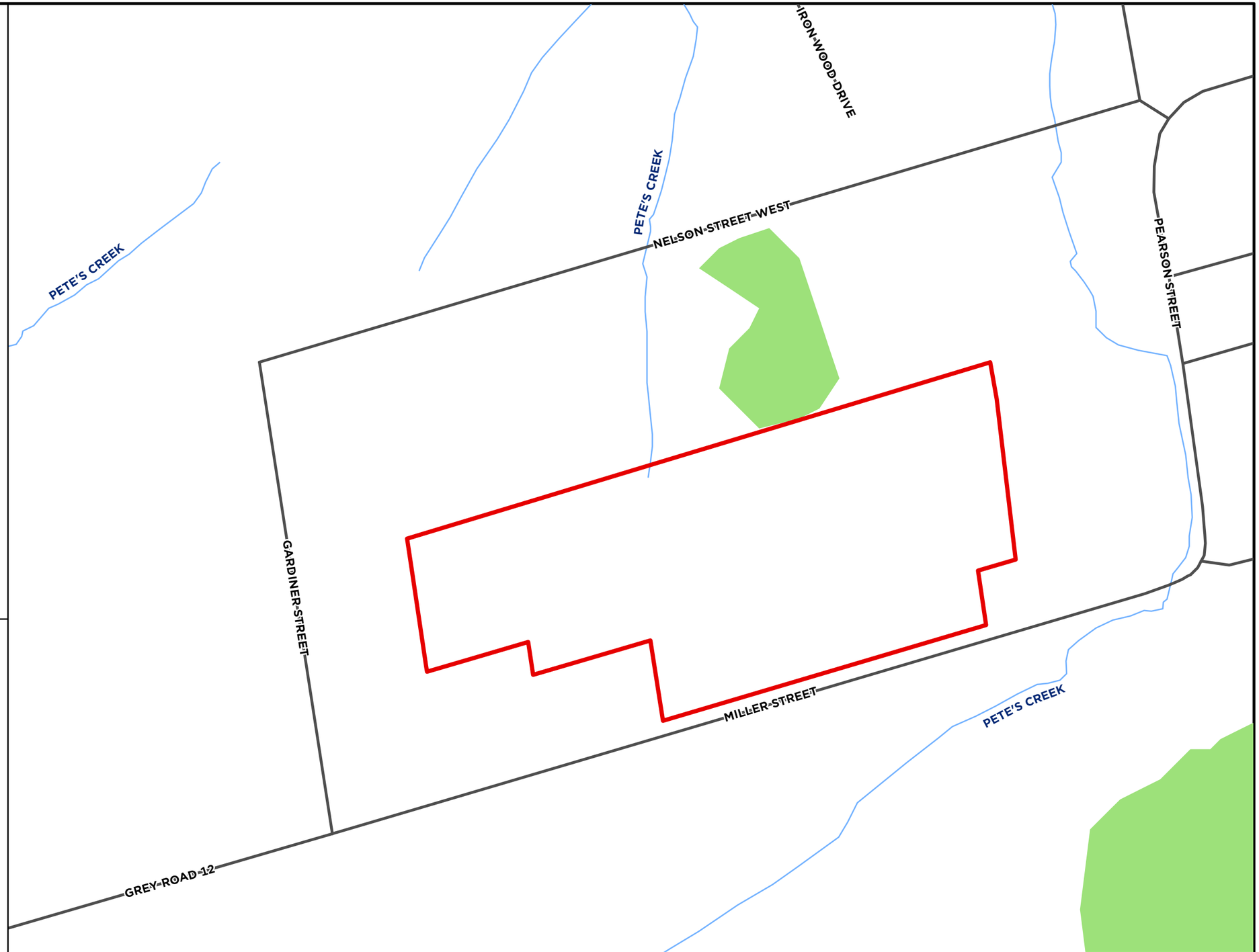
\\col-fs-01\OESFS\Data\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

N

NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- SIGNIFICANT GROUNDWATER RECHARGE AREA
- ROADS
- WATERCOURSES
- WATERBODY
- WOODED AREA



0 50 100 200 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
SIGNIFICANT GROUNDWATER RECHARGE AREA

DWG. No. **FIG-4**

SCALE: 1:3,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

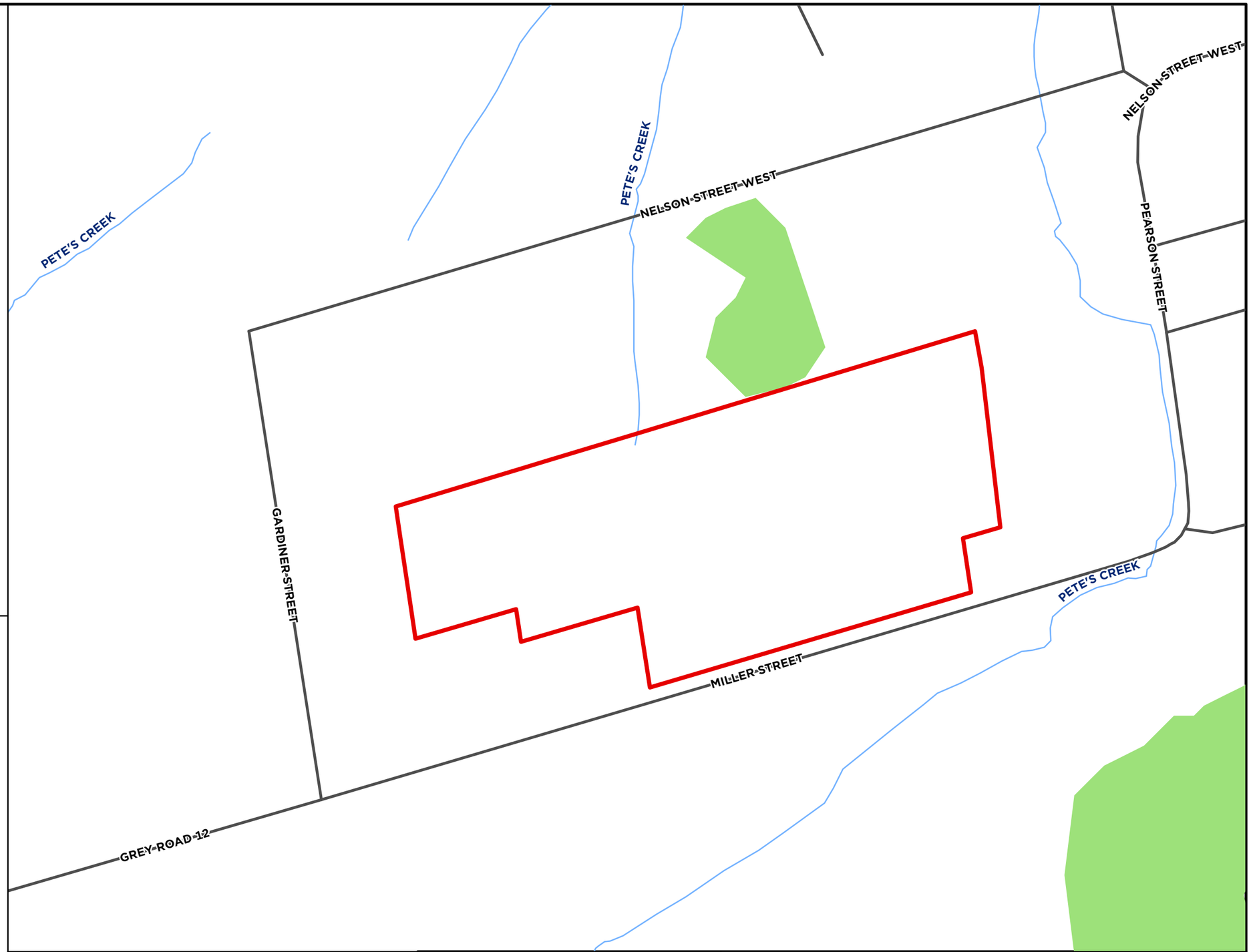
\\col-fs-01\OESFS\Data\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

N

NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- HIGHLY VULNERABLE AQUIFER
- ROADS
- WATERCOURSES
- WATERBODY
- WOODED AREA



0 50 100 200 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
HIGHLY VULNERABLE AQUIFER

DWG. No. **FIG-5**

SCALE: 1:3,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

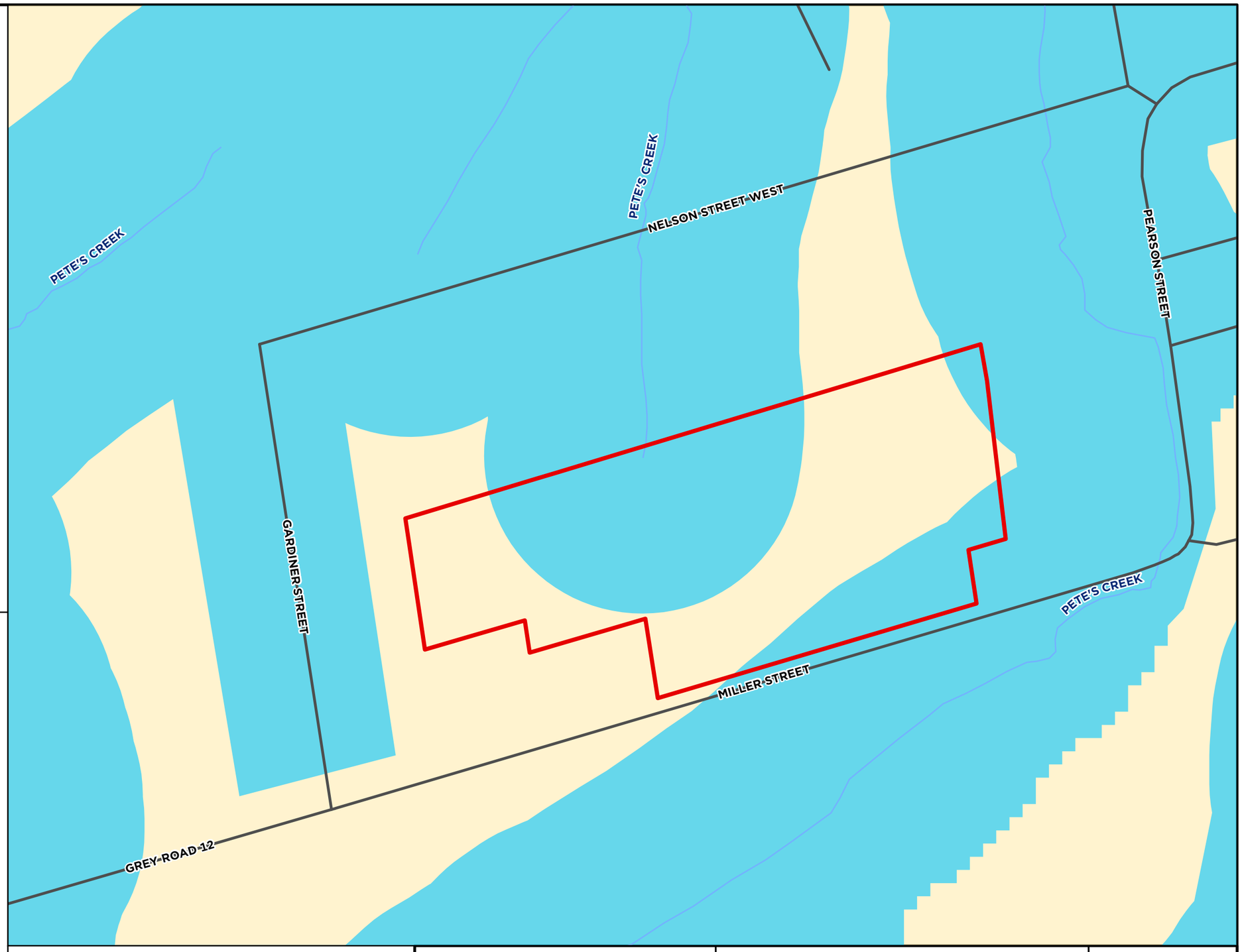
\\col-fs-01\OESFS\Data\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

N

NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- INTAKE PROTECTION ZONE 1
- INTAKE PROTECTION ZONE 2
- INTAKE PROTECTION ZONE 3
- ROADS
- WATERCOURSES



0 50 100 200 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
INTAKE PROTECTION ZONE

DWG. No. **FIG-6**

SCALE: 1:3,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

\\col-fs-01\OESFS\Data\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

N

NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- BOREHOLES (GREEN, 2023)
- MONITORING WELL (GREEN, 2023)
- WATERCOURSES

0 30 60 120 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
BOREHOLE/MONITORING WELL LOCATION PLAN

DWG. No. **FIG-7**

SCALE: 1:2,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

O:\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

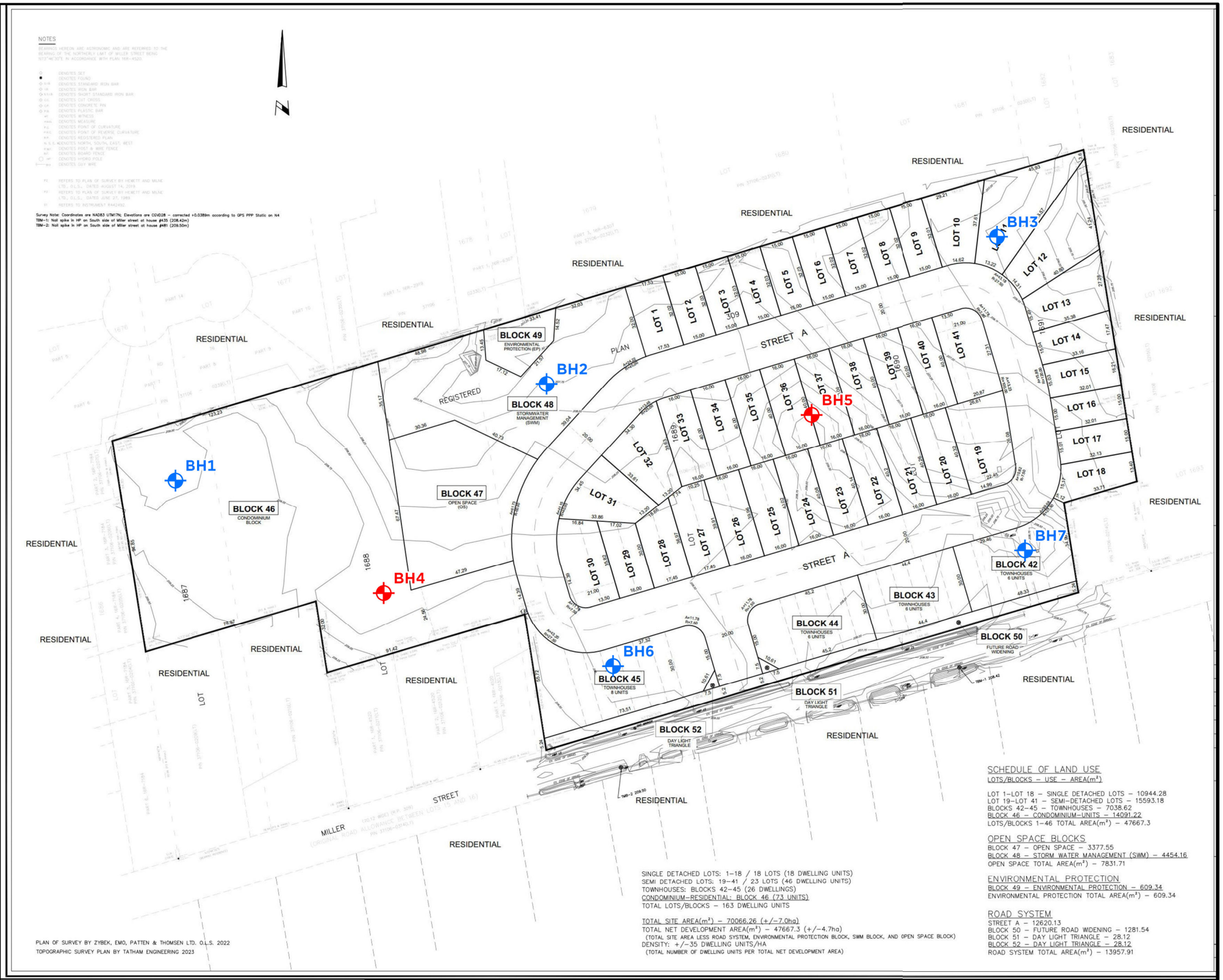
N

NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- BOREHOLES (GREEN, 2023)
- MONITORING WELL (GREEN, 2023)



0 30 60 120 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
BOREHOLE/MONITORING WELL LOCATION PLAN - SITE PLAN

DWG. No. **FIG-8**

SCALE: 1:1,900 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

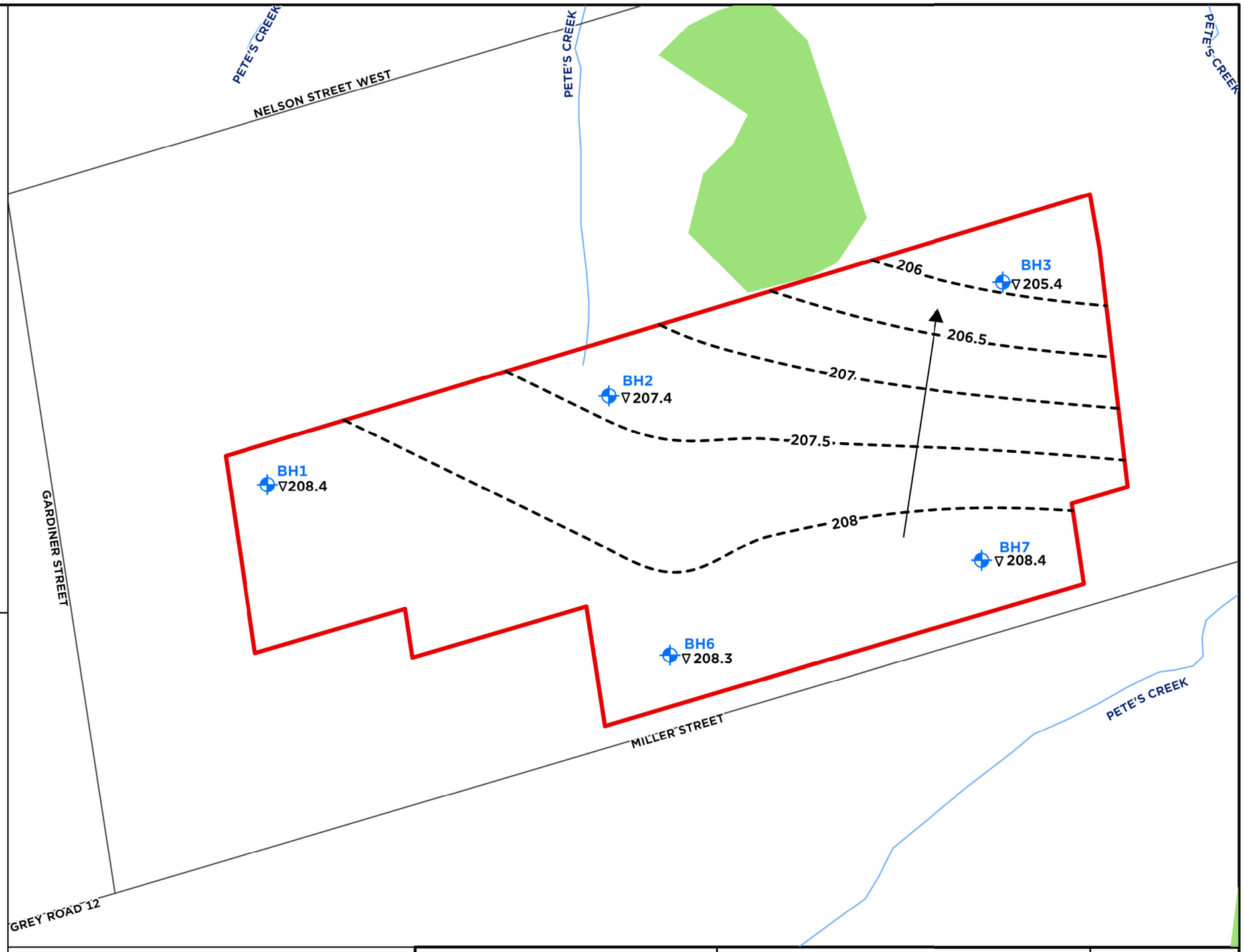
O:\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

N

NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2.CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE – ONTARIO.

LEGEND

- SITE
- MONITORING WELL (GREEN, 2023)
- WATERCOURSES
- WOODED AREA
- CONTOUR_SPLINE_4_CLIP
- GROUNDWATER ELEVATION (MEASURED DECEMBER 6, 2023)
- GROUNDWATER FLOW DIRECTION



0 30 60 120 METERS

TATHAM ENGINEERING

412 MILLER STREET, MEAFORD
HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER CONTOUR

DWG. No. **FIG-9**

SCALE: 1:2,000 | DRAWN: AO | DATE: DEC. 2023 | JOB NO. 122076

O:\Collingwood\2022 Projects\122076 - 412 Miller Street, Meaford\GIS\122076 - 412 Miller Street, Meaford\122076 - 412 Miller Street, Meaford.aprx

Appendix A:
MECP Well Records

TATHAM ENGINEERING

Ministry of the Environment, Conservation and Parks
Water Well Records

Township Con Lot	UTM	Date Centr	Casing Dia	Water	Pump Test	Well Use	Screen Depth	Well	Formation
MEAFORD TOWN	17 531434 4939373 W	2019/09 1565						7344197 (Z305472) A263576 A	STNS 0016
ST VINCENT TOWNSHIP CON 05 016	17 531739 4939305 W	2020/09 7190	2 6		0///:	MO	0008 5	7370976 (GWU54U OO) A300315	BRWN GRVL 0002 BRWN SAND GRVL 0010 GREY SAND SILT 0013
ST VINCENT TOWNSHIP CON 05 016	17 531533 4939243 W	2020/09 7190	2 6		0///:	MO	0008 5	7370978 (6P4HCT4 X) A300317	BRWN GRVL 0002 BRWN SAND SILT 0010 GREY CLAY SILT 0013
ST VINCENT TOWNSHIP CON 06 015	17 530926 4938385 L	1997/06 1565	6	FR 0134	33/40/8/24:0	DO	0133 4	2513298 (177450)	LOAM 0001 BRWN CLAY STNS 0112 BRWN CLAY FSND LYRD 0130 FSND 0137 SAND MGRD 0137
ST VINCENT TOWNSHIP CON 06 016	17 530694 4938704 W	1975/04 3741	6	FR 0057	14/25/5/4:30	DO		2505053 ()	LOAM 0001 CLAY LOAM 0003 CLAY SAND 0025 CLAY SAND GRVL 0057 SAND GRVL SILT 0059
ST VINCENT TOWNSHIP CON 06 016	17 530830 4938996 L	1998/06 1565	6	FR 0125 FR 0130	14/84/8/99:5 9	DO	0125 4	2513573 (194139)	BRWN CLAY SNDY 0015 BRWN CLAY STKY 0030 BRWN CLAY GRVL 0060 BRWN GRVL CLAY SAND 0098 CLAY SAND 0120 SAND MGRD 0130
ST VINCENT TOWNSHIP CON 06 016	17 530830 4938996 L	1996/11 1565	6	FR 0141	18/25/15/24: 0	DO	0141 4	2513198 (157499)	LOAM 0001 CLAY SNDY 0019 CLAY STNS 0040 CLAY GRVL 0095 GRVL CLAY 0120 CLAY SAND 0138 SAND MGRD 0145
ST VINCENT TOWNSHIP CON 06 016	17 530677 4938669 W	1993/07 3741	6	FR 0109	27/45/8/4:30	DO	0105 4	2512487 (122377)	LOAM 0001 CLAY SILT 0007 GREY CLAY GRVL 0056 CSND SILT 0069 CLAY GRVL 0088 CSND SLTY 0103 CSND 0109 FSND 0110

TATHAM ENGINEERING

Ministry of the Environment, Conservation and Parks
Water Well Records

UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completed and Well Contractor Licence Number
CASING DIA: Casing diameter in inches
WATER: Unit of Depth in Feet. See Table 4 for meanign of code.
PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hr : Min
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag. A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

Table 1: Core Material and Descriptive Terms

BLDR BOULDERS	FCRD FRACTURED	IRFM IRON FORMATION	PORS POROUS	SOFT SOFT
BSLT BASALT	FGRD FINE-GRAINED	LIMY LIMY	PRDG PREVIOUSLY DUG	SPST SOAPSTONE
CGRD COARSE-GRAINED	FGVL FINE GRAVEL	LMSN LIMESTONE	PRDR PREV. DRILLED	STKY STICKY
CGVL COARSE GRAVEL	FILL FILL	LOAM TOPSOIL	QRTZ QUARTZITE	STNS STONES
CHRT CHERT	FLDS FELDSPAR	LOOS LOOSE	QSND QUICKSAND	STNY STONEY
CLAY CLAY	FLNT FLINT	LTCL LIGHT-COLOURED	QTZ QUARTZ	THIK THICK
CLN CLEAN	FOSS FOSILIFEROUS	LYRD LAYERED	ROCK ROCK	THIN THIN
CLYY CLAYEY	FSND FINE SAND	MARL MARL	SAND SAND	TILL TILL
CMTD CEMENTED	GNIS GNEISS	MGRD MEDIUM-GRAINED	SHLE SHALE	UNKN UNKNOWN TYPE
CONG CONGLOMERATE	GRNT GRANITE	MGVL MEDIUM GRAVEL	SHLY SHALY	VERY VERY
CRYS CRYSTALLINE	GRSN GREENSTONE	MRBL MARBLE	SHRP SHARP	WBRG WATER-BEARING
CSND COARSE SAND	GRVL GRAVEL	MSND MEDIUM SAND	SHST SCHIST	WDFR WOOD FRAGMENTS
DKCL DARK-COLOURED	GRWK GREYWACKE	MUCK MUCK	SILT SILT	WTHD WEATHERED
DLMT DOLOMITE	GVLY GRAVELLY	OBDN OVERBURDEN	SLTE SLATE	
DNSE DENSE	GYPS GYPSUM	PCKD PACKED	SLTY SILTY	
DRTY DIRTY	HARD HARD	PEAT PEAT	SNDS SANDSTONE	
DRY DRY	HPAN HARDPAN	PGVL PEA GRAVEL	SNDY SANDYOAPSTONE	

Table 2: Core Color

WHIT WHITE
GREY GREY
BLUE BLUE
GREN GREEN
YLLW YELLOW
BRWN BROWN
RED RED
BLCK BLACK
BLGY BLUE-GREY

Table 3: Well Use

DO Domestic	OT Other
ST Livestock	TH Test Hole
IR Irrigation	DE Dewatering
IN Industrial	MO Monitoring
CO Commercial	MT Monitoring TestHole
MN Municipal	
PS Public	
AC Cooling And A/C	
NU Not Used	

Table 4:Water Detail

FR Fresh	GS Gas
SA Salty	IR Iron
SU Sulphur	
MN Mineral	
UK Unknown	

Appendix B:
Borehole Logs

SYMBOLS and ABBREVIATIONS USED ON BOREHOLE LOGS

PROPORTIONAL TERMS

Term	Proportion
trace	0 to 10%
some	10 to 20%
-y or -ey	20 to 35%
and	>35%

MOISTURE DESCRIPTION

Term	Description
dry	No observable pore moisture
moist	Inferred pore moisture, no observable free water
wet	Weakened by moisture, free water on hands when handling

CONSISTENCY of COARSE-GRAINED SOILS

Consistency	Blow Count N
very loose	< 4
loose	4 to 10
compact	10 to 30
dense	30 to 50
very dense	> 50

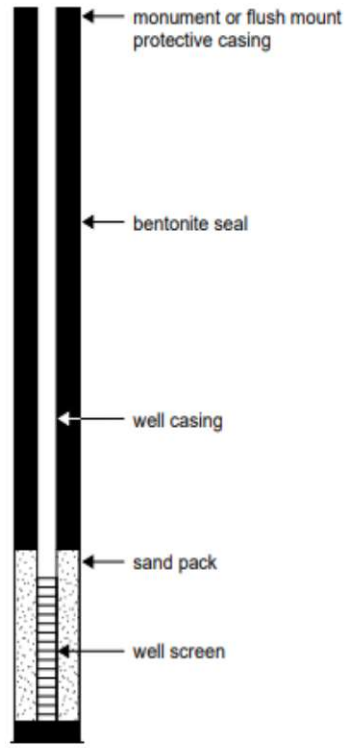
Notes: SPT/DCPT 'N' values are 'raw' field blow counts, measured for 300 mm (12 inch) of penetration.

CONSISTENCY of FINE-GRAINED SOILS

Consistency	Blow Count N	Undrained Shear Strength Su (kPa)	
very soft	< 2	< 12	Easily exudes between fingers when squeezed
soft	2 to 4	12 to 25	Easily intended by fingers
firm	4 to 8	25 to 50	Can be intended by strong finger or thumb pressure
stiff	8 to 16	50 to 100	Cannot be intended by thumb pressure
very stiff	16 to 30	100 to 200	Can be intended by thumb nail
hard	> 30	> 200	Difficult to intend by thumb nail

ASTM STANDARDS
ASTM D1568 Standard Penetration Test (SPT) - Driving a 51 mm O.D. split-barrel sampler ("split spoon") into soil with a 63.5 kg weight free falling 760mm. The blows required to drive the split spoon 300mm ("bpf") after an initial penetration of 150 mm is referred to as the N-Value.
ASTM D1568 Cone Penetration Test (CPT) - Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 Into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.
ASTM D2573 Field Vane Test (FVT) - Pushing a four blade vane into soil and rotating it from the surface to determine the torque required to shear a cylindrical surface with the vane. The torque is converted to the shear strength of the soil using a limit equilibrium analysis.
ASTM D1587 Shelby Tubes (ST) - Pushing a thin-walled metal tube into the in-situ soil at the bottom of a borehole, removing the tube and sealing the ends to prevent soil movement or changes in moisture content for the purposes of extracting a relatively undisturbed sample.

WELL LEGEND



SYMBOL	Description
AS	Auger Sample
CC	Continuous Core Sample
DC	Drill Cuttings
GS	Grab Sample
SS	SPT Spoon Sample
TS	Thin-walled / Shelby Sample
WS	Water Sample

SYMBOL	Description
▼	Measured in a piezometer or well
▽	Inferred water level based on observations during investigation

BOREHOLE LOG: BH1

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 530962 | Northing: 4938896 | Elevation:208.9 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 17, 2023

Ground Surface at 208.9 m EL 208.9 m

TOPSOIL
0.3 m
EL 208.6 m

WEATHERED/DISTURBED
0.6 m
EL 208.3 m

SILT TO SANDY SILT
trace clay, loose to very dense, moist to wet, brown to grey-brown

6.6 m
EL 202.3 m

BH1 Terminated at 6.6 m

NO.	TYPE	SPT	DCPT	NOTES/GRAIN SIZE (%)
1	SS	4	3, 4	
2	SS	10	13, 14	
3	SS	7	10, 14	
4	SS	39	12, 31	
5	SS	45		
6	SS	(75)		Grey-brown below
7	SS	21		Wet below

17 Oct 2023

Notes:
Unstabilized water level measured at 5.8 mbg (elev. 203.1 m).
Borehole was open upon completion of drilling.
Stabilized water level measured at 0.6 mbg (elev. 208.3 m) on 12-06-23

BOREHOLE LOG: BH2

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 531113 | Northing: 4938933 | Elevation:207.7 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 17, 2023

Ground Surface at 207.7 m EL 207.7 m

TOPSOIL
0.3 m
EL 207.4 m

FILL
silty sand to sandy silt, trace construction debris, trace organic inclusions, very loose, moist, dark brown
0.6 m
EL 207.1 m

SILT TO CLAYEY SILT
trace to some sand, stiff to hard, moist to wet, brown to grey

6.6 m
EL 201.1 m
BH2 Terminated at 6.6 m

NO.	TYPE	SPT (N)	DCPT	NOTES/GRAIN SIZE (%)
1	SS	3		
2	SS	14		
3	SS	22		
4	SS	34		
5	SS	34		Grey below
6	SS	17		
7	SS	12		Wet below

17 Oct 2023

Notes:
Unstabilized water level measured at 3.5 mbg (elev. 204.2m).
Borehole was open upon completion of drilling.
Stabilized water level measured at 0.3 mbg (elev. 207.4m) on 12-06-23

BOREHOLE LOG: BH3

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 531315 | Northing: 4939000 | Elevation:206.5 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 17, 2023

Ground Surface at 206.5 m EL 206.5 m

TOPSOIL
0.3 m
EL 206.2 m

SILT TO SANDY SILT
trace clay, loose, moist, brown
0.6 m
EL 205.9 m

SILT TO CLAYEY SILT
trace to some sand, firm to very stiff, moist, brown to grey

6.1 m
EL 200.4 m

SILTY CLAY
trace sand, firm, moist to wet, grey
6.6 m
EL 199.9 m

BH3 Terminated at 6.6 m

NO.	TYPE	SPT	DCPT	NOTES/GRAIN SIZE (%)
1	SS	6	3, 7	
2	SS	17	15, 25, 38	
3	SS	24	33, 38	
4	SS	12	39, 42, 47	
5	SS	9	(61)	Grey and wet below
6	SS	6	(58), (55), (59), (62), (64), (63), (66), (65), (70)	
7	SS	5		

Notes:
Borehole was open and dry upon completion of drilling.
Stabilized water level measured at 0.6 mbg (elev. 205.9 m) on 12-06-23

BOREHOLE LOG: BH4

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 531046 | Northing: 4938848 | Elevation:208.7 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 17, 2023

Ground Surface at 208.7 m EL 208.7 m

DEPTH	SOIL STRATIGRAPHY	SYMBOL	SAMPLES NO.	SAMPLES TYPE	STANDARD PENETRATION TEST (SPT)	DYNAMIC CONE PENETRATION TEST (DCPT)	NOTES/GRAIN SIZE (%)	MONITORING WELL	MOISTURE PLOT
0	**TOPSOIL** 0.3 m EL 208.4 m		1	SS	5			No Data	
	(WEATHERED/DISTURBED) 0.6 m EL 208.1 m								
1	**SILT TO SANDY SILT** trace clay, loose, moist, brown		2	SS	8		Gr:1%, Sa:40%, Si:49%, Cl:10%		
	1.5 m EL 207.2 m								
2	**SILT TO CLAYEY SILT** trace to some sand, moist to wet, very stiff, brown to grey		3	SS	20				
			4	SS	31				
3			5	SS	25				
4									
5			6	SS	18		Grey and wet below		
6									
7			7	SS	22				
	6.6 m EL 202.1 m								
	BH4 Terminated at 6.6 m								

MOISTURE PLOT: W_{PL} — W — W_{LL}; 20 40 60 80

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH5

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 531240 | Northing: 4938914 | Elevation:209 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 18, 2023

Ground Surface at 209 m EL 209 m

TOPSOIL 0.1 m, EL 208.9 m

(WEATHERED/DISTURBED) 0.6 m, EL 208.4 m

SILT TO SANDY SILT

trace clay, loose, moist, brown

2.3 m, EL 206.7 m

SILT TO CLAYEY SILT

trace to some sand, stiff to very stiff, moist to wet, brown to grey

Grey and wet below

6.6 m, EL 202.4 m

BH5 Terminated at 6.6 m

DEPTH	NO.	TYPE	STANDARD PENETRATION TEST (SPT)	DYNAMIC CONE PENETRATION TEST (DCPT)
0	1	SS	3	4, 4
1	2	SS	7	7, 18
2	3	SS	6	10, 8, 15
3	4	SS	14	18
4	5	SS	14	
5	6	SS	20	
6	7	SS	13	
7				

NOTES/GRAIN SIZE (%): No Data

MONITORING WELL

MOISTURE PLOT: W_{PL} — W — W_{LL}; 20 40 60 80

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH6

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 531149 | Northing: 4938804 | Elevation:208.7 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 18, 2023

Ground Surface at 208.7 m EL 208.7 m

DEPTH	SOIL STRATIGRAPHY	SYMBOL	SAMPLES NO.	SAMPLES TYPE	STANDARD PENETRATION TEST (SPT)	DYNAMIC CONE PENETRATION TEST (DCPT)	NOTES/GRAIN SIZE (%)	MONITORING WELL	MOISTURE PLOT
0	**TOPSOIL** 0.2 m EL 208.5 m		1	SS	3				
	(WEATHERED/DISTURBED) 0.6 m EL 208.1 m		2	SS	8				
1	**SILT TO SANDY SILT** trace clay, loose, moist, brown 1.5 m EL 207.2 m								
2	**SILT TO CLAYEY SILT** trace to some sand, very stiff, moist to wet, brown to grey		3	SS	16				
			4	SS	29				
3			5	SS	22		Gr:0%, Sa:7% Si:77%, Cl:16%		
4									
			6	SS	20		Grey and wet below		
5									
6	18 Oct 2023								
			7	SS	17				
7	6.6 m EL 202.1 m BH6 Terminated at 6.6 m								

STANDARD PENETRATION TEST (SPT): 0 10 20 30 40 50

DYNAMIC CONE PENETRATION TEST (DCPT): 0 10 20 30 40 50

MOISTURE PLOT: W_{PL} — W — W_{LL}; 20 40 60 80

Notes:
Unstabilized water level measured at 5.9 mbg (elev. 202.8 m).
Borehole was open upon completion of drilling.
Stabilized water level measured at 0.4 mbg (elev. 208.3 m) on 12-06-23

BOREHOLE LOG: BH7

Project: Proposed Residential Subdivision | Project No.: 23-087-01

Site Address: 412 Miller Street, Meaford, ON | Client: Harry Littler

Easting: 531308 | Northing: 4938848 | Elevation:208.7 m

Logged By: NC | Reviewed By: TK | Investigation Date: October 18, 2023

Ground Surface at 208.7 m EL 208.7 m

TOPSOIL
0.3 m
EL 208.4 m

(WEATHERED/DISTURBED)
0.6 m
EL 208.1 m

SILT TO SANDY SILT
trace clay, compact, moist, brown
1.5 m
EL 207.2 m

SILT TO CLAYEY SILT
trace to some sand, stiff to very stiff, moist to wet, brown to grey

Grey and wet below

6.6 m
EL 202.1 m

BH7 Terminated at 6.6 m

18 Oct 2023

NO.	TYPE	SPT	DCPT
1	SS	4	3, 3
2	SS	13	14, 18, 18
3	SS	16	26, 30
4	SS	11	34, 39, 49
5	SS	20	
6	SS	13	
7	SS	23	

Notes:
Unstabilized water level measured at 6.2 mbg (elev. 202.5 m).
Borehole was open upon completion of drilling.
Stabilized water level measured at 0.3 mbg (elev. 208.4 m) on 12-06-23

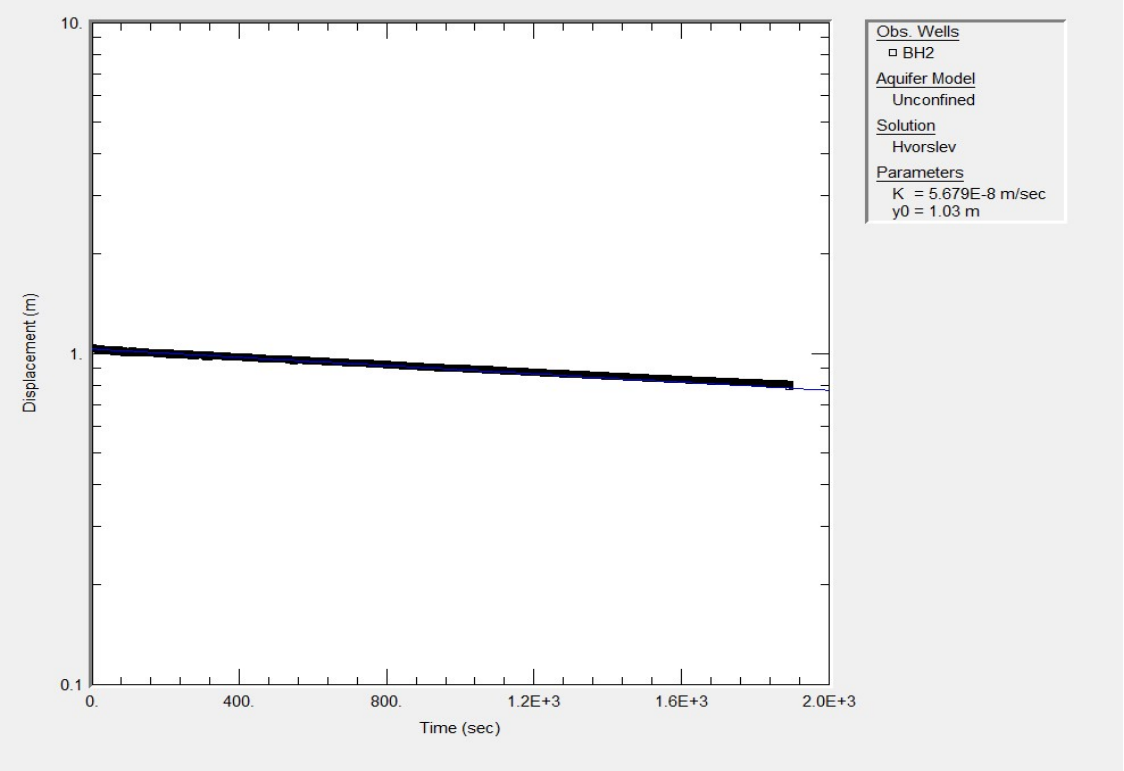
Appendix C:
Rising Head Test Results

TATHAM ENGINEERING

Estimated Hydraulic Conductivity - Slug Test
Hvorslev Equation

Date Completed:	14-Nov-23
Conducted by:	SM

Well Number:	BH2	
Well Screen Bottom:	6.1	mbgs
Top of Pipe:	0.71	mags
Well Casing Diameter:	5	cm
Well Elevation:	207.7	masl
Static Water Level:	0.38	mbgs
K:	5.70E-08	m/s



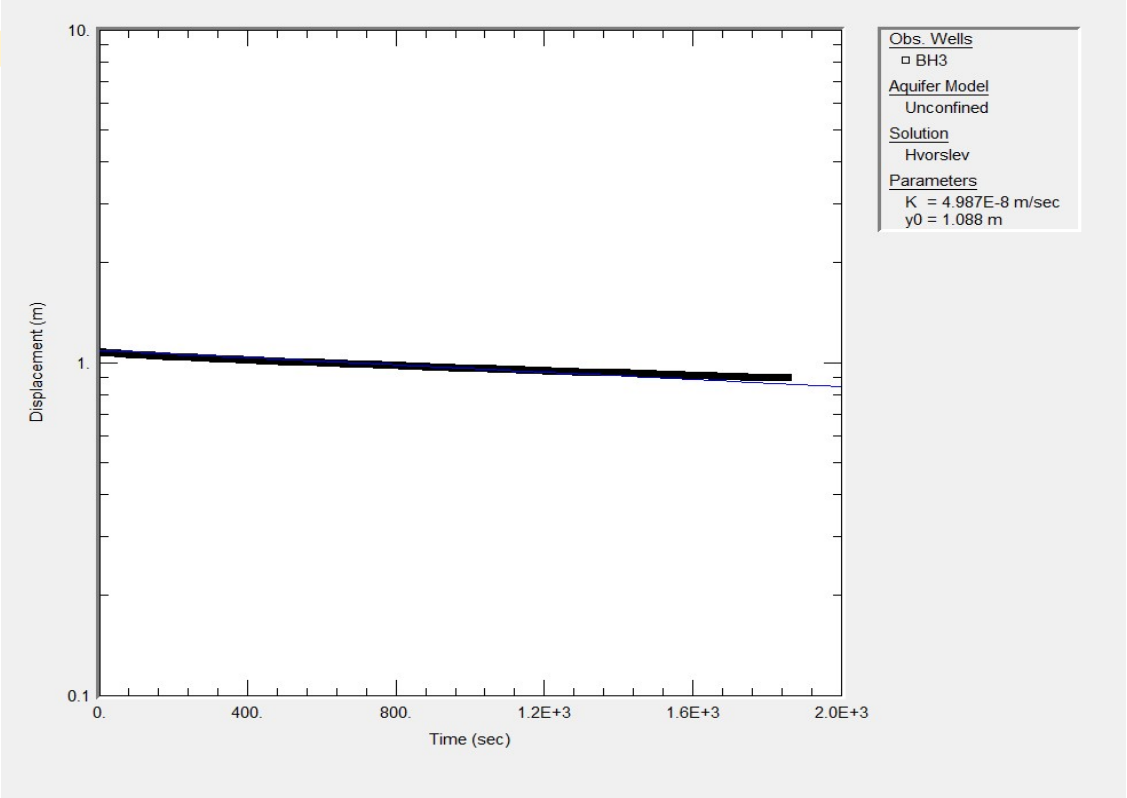
Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

TATHAM ENGINEERING

Estimated Hydraulic Conductivity - Slug Test
Hvorslev Equation

Date Completed:	14-Nov-23
Conducted by:	SM

Well Number:	BH3	
Well Screen Bottom:	6.1	mbgs
Top of Pipe:	0.8	mags
Well Casing Diameter:	5	cm
Well Elevation:	206.5	masl
Static Water Level:	0.84	mbgs
K:	4.99E-08	m/s



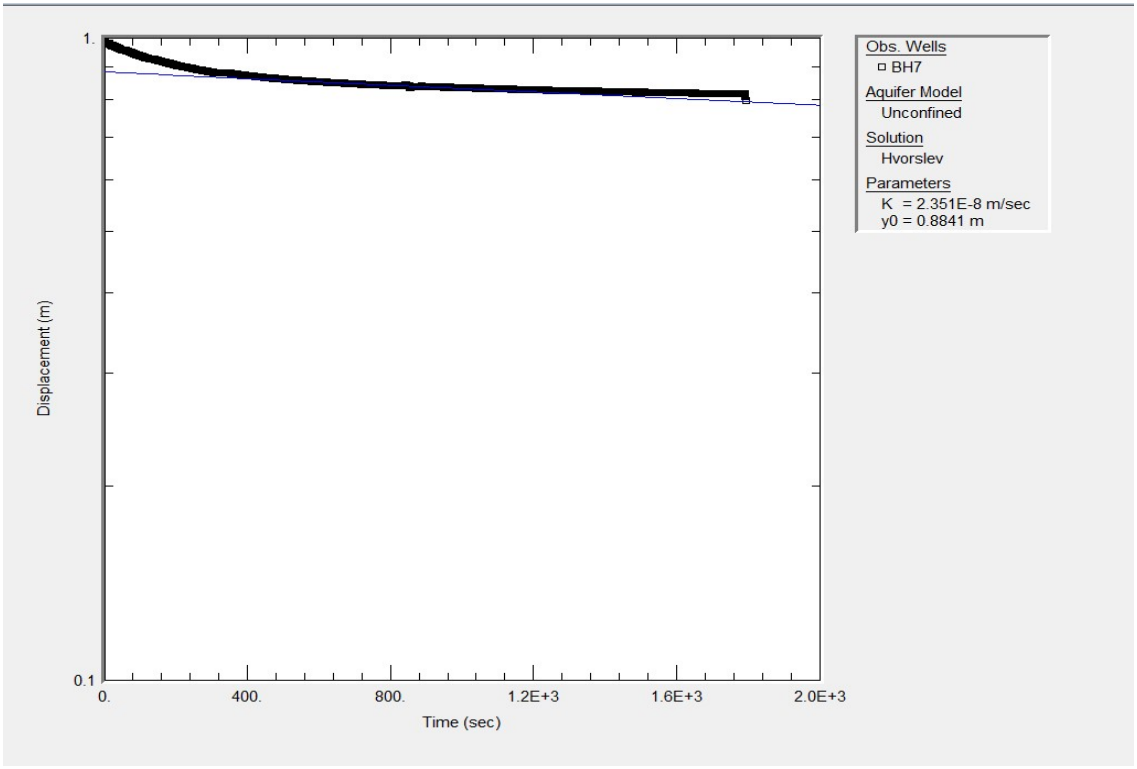
Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

TATHAM ENGINEERING

Estimated Hydraulic Conductivity - Slug Test
Hvorslev Equation

Date Completed:	14-Nov-23
Conducted by:	SM

Well Number:	BH7	
Well Screen Bottom:	6.1	mbgs
Top of Pipe:	0.72	mags
Well Casing Diameter:	5	cm
Well Elevation:	208.7	masl
Static Water Level:	1.41	mbgs
K:	2.35E-08	m/s



Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

Appendix D: Laboratory Certificates of Analysis

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured. Canadian owned.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G114745 **REPORT No: 23-032068 - Rev. 0**

Report To:
Tatham Engineering
115 Sandford Fleming Drive
Suite 200
Collingwood, ON L9Y 5A6

CADUCEON Environmental Laboratories
112 Commerce Park Dr Unit L
Barrie, ON L4N 8W8

Attention: Oliver Lestyan

DATE RECEIVED: 2023-Nov-14
DATE REPORTED: 2023-Nov-22
SAMPLE MATRIX: Ground Water

CUSTOMER PROJECT: 122076
P.O. NUMBER:

Analyses	Qty	Site Analyzed	Authorized	Date Analyzed	Lab Method	Reference Method
Chromium VI (Liquid)	1	OTTAWA	STAILLON	2023-Nov-20	D-CRVI-01	MECP E3056
ICP/MS Total (Liquid)	1	OTTAWA	TPRICE	2023-Nov-20	D-ICPMS-01	EPA 6020
ICP/OES Total (Liquid)	1	OTTAWA	NHOGAN	2023-Nov-17	D-ICP-01	SM 3120B
ICP/OES (Liquid)	1	OTTAWA	NHOGAN	2023-Nov-17	D-ICP-01	SM 3120B
Mercury (Liquid)	1	OTTAWA	TBENNETT	2023-Nov-17	D-HG-02	SM 3112B
PHC F1 (Liquid)	1	RICHMOND_HILL	FLENA	2023-Nov-17	C-VPHW-01	MECP E3421
PHC F2-4 (Liquid)	1	KINGSTON	STHOMPSON	2023-Nov-21	PHC-W-001	MECP E3421
VOC-Volatiles Full (Water)	1	RICHMOND_HILL	FLENA	2023-Nov-17	C-VOC-02	EPA 8260

µg/g = micrograms per gram (parts per million) and is equal to mg/Kg
F1 C6-C10 hydrocarbons in µg/g, (F1-btex if requested)
F2 C10-C16 hydrocarbons in µg/g, (F2-napth if requested)
F3 C16-C34 hydrocarbons in µg/g, (F3-pah if requested)
F4 C34-C50 hydrocarbons in µg/g
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
Any deviations from the method are noted and reported for any particular sample.
nC6 and nC10 response factor is within 30% of response factor for toluene:
nC10,nC16 and nC34 response factors within 10% of each other:
C50 response factors within 70% of nC10+nC16+nC34 average:
Linearity is within 15%:
All results expressed on a dry weight basis.
Unless otherwise noted all chromatograms returned to baseline by the retention time of nC50.

R.L. = Reporting Limit
NC = Not Calculated
Test methods may be modified from specified reference method unless indicated by an *

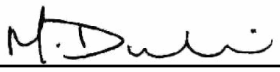
Unless otherwise noted all extraction, analysis, QC requirements and limits for holding time were met.
If analyzed for F4 and F4G they are not to be summed but the greater of the two numbers are to be used in application to the CWS PHC
QC will be made available upon request.

Michelle Dubien
Data Specialist

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	Units	R.L.	Limits		-
Aluminum	µg/L	10	75	INTERIM	43
Hardness (as CaCO3)	mg/L as CaCO3	-			192
Aluminum (Total)	µg/L	10			1610
Boron (Total)	µg/L	5	200	INTERIM	369
Calcium (Total)	µg/L	20			47400
Iron (Total)	µg/L	5	300	PWQO	2340
Magnesium (Total)	µg/L	20			18000
Tungsten (Total)	µg/L	10	30	INTERIM	<10
Zinc (Total)	µg/L	5	20, 30	INTERIM, PWQO	43
Zirconium (Total)	µg/L	3	4	INTERIM	3
Antimony (Total)	µg/L	0.1	20	INTERIM	0.9
Arsenic (Total)	µg/L	0.1	5, 5	INTERIM, PWQO	2.7
Beryllium (Total)	µg/L	0.1	11	PWQO	<0.1
Cadmium (Total)	µg/L	0.015	0.1, 0.2	INTERIM, PWQO	0.021
Chromium (Total)	µg/L	1			2
Cobalt (Total)	µg/L	0.1	0.9	INTERIM	1.2
Copper (Total)	µg/L	0.1	5	INTERIM	7.1
Lead (Total)	µg/L	0.02	1, 5	INTERIM, PWQO	1.22
Molybdenum (Total)	µg/L	0.1	40	INTERIM	7.1
Nickel (Total)	µg/L	0.2	25	PWQO	3.1
Selenium (Total)	µg/L	1	100	PWQO	<1

Michelle Dubien
Data Specialist

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	**Units**	**R.L.**	**Limits**		-
Silver (Total)	µg/L	0.1	0.1	PWQO	<0.1
Thallium (Total)	µg/L	0.05	0.3, 0.3	INTERIM, PWQO	<0.05
Uranium (Total)	µg/L	0.05	5	INTERIM	1.76
Vanadium (Total)	µg/L	0.1	6	INTERIM	2.1
Chromium (VI)	µg/L	1	1	PWQO	<1
Mercury	µg/L	0.02	0.2	PWQO	<0.02

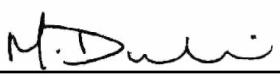


Michelle Dubien
Data Specialist

Parameter	Units	R.L.	Limits		Client I.D.: BH2 Sample I.D.: 23-032068-1 Date Collected: 2023-Nov-14
					-
Acetone	µg/L	30			<30
Benzene	µg/L	0.5	100	INTERIM	<0.5
Bromodichloromethane	µg/L	2	200	INTERIM	<2
Bromoform	µg/L	5	60	INTERIM	<5
Bromomethane	µg/L	0.5	0.9	INTERIM	<0.5
Carbon Tetrachloride	µg/L	0.2			<0.2
Chlorobenzene	µg/L	0.5	15	PWQO	<0.5
Chloroform	µg/L	1			<1
Dibromochloromethane	µg/L	2	40	INTERIM	<2
Ethylene Dibromide	µg/L	0.2	5, 5	INTERIM, PWQO	<0.2
Dichlorobenzene,1,2-	µg/L	0.5	2.5	PWQO	<0.5
Dichlorobenzene,1,3-	µg/L	0.5	2.5	PWQO	<0.5
Dichlorobenzene,1,4-	µg/L	0.5	4	PWQO	<0.5
Dichlorodifluoromethane (Freon 12)	µg/L	2			<2
Dichloroethane,1,1-	µg/L	0.5	200	INTERIM	<0.5
Dichloroethane,1,2-	µg/L	0.5	100	INTERIM	<0.5
Dichloroethylene,1,1-	µg/L	0.5	40	INTERIM	<0.5
Dichloroethylene,1,2-cis-	µg/L	0.5	200	INTERIM	<0.5
Dichloroethylene,1,2-trans-	µg/L	0.5	200	INTERIM	<0.5
Dichloropropane,1,2-	µg/L	0.5	0.7	INTERIM	<0.5
Dichloropropene,1,3-cis-	µg/L	0.5			<0.5

Michelle Dubien
Data Specialist

Parameter	Units	R.L.	Limits		Client I.D.: BH2 Sample I.D.: 23-032068-1 Date Collected: 2023-Nov-14
					-
Dichloropropene,1,3-cis+trans-(Calculated)	µg/L	0.5			<0.5
Dichloropropene,1,3-trans-	µg/L	0.5	7	INTERIM	<0.5
Ethylbenzene	µg/L	0.5	8	INTERIM	<0.5
Hexane	µg/L	5			<5
Dichloromethane (Methylene Chloride)	µg/L	5	100	INTERIM	<5
Methyl Ethyl Ketone	µg/L	20	400	INTERIM	<20
Methyl Isobutyl Ketone	µg/L	20			<20
Methyl tert-Butyl Ether (MTBE)	µg/L	2	200	INTERIM	<2
Styrene	µg/L	0.5	4	INTERIM	<0.5
Tetrachloroethane,1,1,1,2-	µg/L	0.5	20	INTERIM	<0.5
Tetrachloroethane,1,1,2,2-	µg/L	0.5	70	INTERIM	<0.5
Tetrachloroethylene	µg/L	0.5	50	INTERIM	<0.5
Toluene	µg/L	0.5	0.8, 0.8	INTERIM, PWQO	<0.5
Trichloroethane,1,1,1-	µg/L	0.5	10	INTERIM	<0.5
Trichloroethane,1,1,2-	µg/L	0.5	800	INTERIM	<0.5
Trichloroethylene	µg/L	0.5	20	INTERIM	<0.5
Trichlorofluoromethane (Freon 11)	µg/L	5			<5
Vinyl Chloride	µg/L	0.2	600	INTERIM	<0.2
Xylene, m,p-	µg/L	1			<1
Xylene, m,p,o-	µg/L	1.1			<1.1
Xylene, o-	µg/L	0.5	40	INTERIM	<0.5



Michelle Dubien
Data Specialist

Parameter	Units	R.L.	Limits		Client I.D.: BH2 Sample I.D.: 23-032068-1 Date Collected: 2023-Nov-14
					-
PHC F1 (C6-C10)	µg/L	25			<25
PHC F2 (>C10-C16)	µg/L	50			<50
PHC F3 (>C16-C34)	µg/L	400			<400
PHC F4 (>C34-C50)	µg/L	400			<400

: PWQO Limits
INTERIM: Interim PWQO
PWQO: PWQO

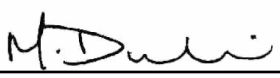
Summary of Exceedances

Interim PWQO

BH2	Found Value	Limit
Boron (Total)	369	200
Zinc (Total)	43	20
Cobalt (Total)	1.2	0.9
Copper (Total)	7.1	5
Lead (Total)	1.22	1

PWQO

BH2	Found Value	Limit
Iron (Total)	2340	300
Zinc (Total)	43	30



Michelle Dubien
Data Specialist

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured. Canadian owned.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G114745 **REPORT No: 23-032068 - Rev. 0**

Report To:
Tatham Engineering
115 Sandford Fleming Drive
Suite 200
Collingwood, ON L9Y 5A6

CADUCEON Environmental Laboratories
112 Commerce Park Dr Unit L
Barrie, ON L4N 8W8

Attention: Oliver Lestyan

DATE RECEIVED: 2023-Nov-14
DATE REPORTED: 2023-Nov-27
SAMPLE MATRIX: Ground Water

CUSTOMER PROJECT: 122076
P.O. NUMBER:

Analyses	Qty	Site Analyzed	Authorized	Date Analyzed	Lab Method	Reference Method
Chromium VI (Liquid)	1	OTTAWA	STAILLON	2023-Nov-20	D-CRVI-01	MECP E3056
ICP/MS Total (Liquid)	1	OTTAWA	TPRICE	2023-Nov-20	D-ICPMS-01	EPA 6020
ICP/OES Total (Liquid)	1	OTTAWA	NHOGAN	2023-Nov-17	D-ICP-01	SM 3120B
ICP/OES (Liquid)	1	OTTAWA	NHOGAN	2023-Nov-17	D-ICP-01	SM 3120B
Mercury (Liquid)	1	OTTAWA	TBENNETT	2023-Nov-17	D-HG-02	SM 3112B
PHC F1 (Liquid)	1	RICHMOND_HILL	FLENA	2023-Nov-17	C-VPHW-01	MECP E3421
PHC F2-4 (Liquid)	1	KINGSTON	STHOMPSON	2023-Nov-21	PHC-W-001	MECP E3421
VOC-Volatiles Full (Water)	1	RICHMOND_HILL	FLENA	2023-Nov-17	C-VOC-02	EPA 8260

µg/g = micrograms per gram (parts per million) and is equal to mg/Kg
F1 C6-C10 hydrocarbons in µg/g, (F1-btex if requested)
F2 C10-C16 hydrocarbons in µg/g, (F2-napth if requested)
F3 C16-C34 hydrocarbons in µg/g, (F3-pah if requested)
F4 C34-C50 hydrocarbons in µg/g
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
Any deviations from the method are noted and reported for any particular sample.
nC6 and nC10 response factor is within 30% of response factor for toluene:
nC10,nC16 and nC34 response factors within 10% of each other:
C50 response factors within 70% of nC10+nC16+nC34 average:
Linearity is within 15%:
All results expressed on a dry weight basis.
Unless otherwise noted all chromatograms returned to baseline by the retention time of nC50.

R.L. = Reporting Limit
NC = Not Calculated
Test methods may be modified from specified reference method unless indicated by an *

Unless otherwise noted all extraction, analysis, QC requirements and limits for holding time were met.
If analyzed for F4 and F4G they are not to be summed but the greater of the two numbers are to be used in application to the CWS PHC
QC will be made available upon request.

Christine Burke
Laboratory Manager

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	Units	R.L.	Limits	Reg 153 - Liquid	-
Aluminum	µg/L	10.0			43.0
Hardness (as CaCO3)	mg/L	-			192
Aluminum (Total)	mg/L	0.01			1.61
Boron (Total)	mg/L	0.005			0.369
Calcium (Total)	mg/L	0.02			47.4
Iron (Total)	mg/L	0.005			2.34
Magnesium (Total)	mg/L	0.02			18.0
Tungsten (Total)	mg/L	0.01			<0.01
Zinc (Total)	mg/L	0.005			0.043
Zirconium (Total)	mg/L	0.003			0.003
Antimony (Total)	mg/L	0.0001			0.0009
Arsenic (Total)	mg/L	0.0001			0.0027
Beryllium (Total)	mg/L	0.0001			<0.0001
Cadmium (Total)	mg/L	0.000015			0.000021
Chromium (Total)	mg/L	0.001			0.002
Cobalt (Total)	mg/L	0.0001			0.0012
Copper (Total)	mg/L	0.0001			0.0071
Lead (Total)	mg/L	0.00002			0.00122
Molybdenum (Total)	mg/L	0.0001			0.0071
Nickel (Total)	mg/L	0.0002			0.0031
Selenium (Total)	mg/L	0.001			<0.001

Christine Burke
Laboratory Manager

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	Units	R.L.	Limits	Reg 153 - Liquid	-
Silver (Total)	mg/L	0.0001			<0.0001
Thallium (Total)	mg/L	0.00005			<0.00005
Uranium (Total)	mg/L	0.00005			0.00176
Vanadium (Total)	mg/L	0.0001			0.0021
Chromium (VI)	µg/L	1	25	T1GW	<1
Mercury	µg/L	0.02	0.1	T1GW	<0.02

Christine Burke
Laboratory Manager

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	Units	R.L.	Limits	Reg 153 - Liquid	-
Acetone	µg/L	30	2700	T1GW	<30
Benzene	µg/L	0.5	0.5	T1GW	<0.5
Bromodichloromethane	µg/L	2	2	T1GW	<2
Bromoform	µg/L	5	5	T1GW	<5
Bromomethane	µg/L	0.5	0.89	T1GW	<0.5
Carbon Tetrachloride	µg/L	0.2	0.2	T1GW	<0.2
Chlorobenzene	µg/L	0.5	0.5	T1GW	<0.5
Chloroform	µg/L	1	2	T1GW	<1
Dibromochloromethane	µg/L	2	2	T1GW	<2
Ethylene Dibromide	µg/L	0.2	0.2	T1GW	<0.2
Dichlorobenzene,1,2-	µg/L	0.5	0.5	T1GW	<0.5
Dichlorobenzene,1,3-	µg/L	0.5	0.5	T1GW	<0.5
Dichlorobenzene,1,4-	µg/L	0.5	0.5	T1GW	<0.5
Dichlorodifluoromethane (Freon 12)	µg/L	2	590	T1GW	<2
Dichloroethane,1,1-	µg/L	0.5	0.5	T1GW	<0.5
Dichloroethane,1,2-	µg/L	0.5	0.5	T1GW	<0.5
Dichloroethylene,1,1-	µg/L	0.5	0.5	T1GW	<0.5
Dichloroethylene,1,2-cis-	µg/L	0.5	1.6	T1GW	<0.5
Dichloroethylene,1,2-trans-	µg/L	0.5	1.6	T1GW	<0.5
Dichloropropane,1,2-	µg/L	0.5	0.5	T1GW	<0.5
Dichloropropene,1,3-cis-	µg/L	0.5			<0.5

Christine Burke
Laboratory Manager

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	Units	R.L.	Limits	Reg 153 - Liquid	-
Dichloropropene,1,3-cis+trans-(Calculated)	µg/L	0.5	0.5	T1GW	<0.5
Dichloropropene,1,3-trans-	µg/L	0.5			<0.5
Ethylbenzene	µg/L	0.5	0.5	T1GW	<0.5
Hexane	µg/L	5	5	T1GW	<5
Dichloromethane (Methylene Chloride)	µg/L	5	5	T1GW	<5
Methyl Ethyl Ketone	µg/L	20	400	T1GW	<20
Methyl Isobutyl Ketone	µg/L	20	640	T1GW	<20
Methyl tert-Butyl Ether (MTBE)	µg/L	2	15	T1GW	<2
Styrene	µg/L	0.5	0.5	T1GW	<0.5
Tetrachloroethane,1,1,1,2-	µg/L	0.5	1.1	T1GW	<0.5
Tetrachloroethane,1,1,2,2-	µg/L	0.5	0.5	T1GW	<0.5
Tetrachloroethylene	µg/L	0.5	0.5	T1GW	<0.5
Toluene	µg/L	0.5	0.8	T1GW	<0.5
Trichloroethane,1,1,1-	µg/L	0.5	0.5	T1GW	<0.5
Trichloroethane,1,1,2-	µg/L	0.5	0.5	T1GW	<0.5
Trichloroethylene	µg/L	0.5	0.5	T1GW	<0.5
Trichlorofluoromethane (Freon 11)	µg/L	5	150	T1GW	<5
Vinyl Chloride	µg/L	0.2	0.5	T1GW	<0.2
Xylene, m,p-	µg/L	1			<1
Xylene, m,p,o-	µg/L	1.1	72	T1GW	<1.1
Xylene, o-	µg/L	0.5			<0.5

Christine Burke
Laboratory Manager

				Client I.D.	BH2
				Sample I.D.	23-032068-1
				Date Collected	2023-Nov-14
Parameter	**Units**	**R.L.**	**Limits**	**Reg 153 - Liquid**	-
PHC F1 (C6-C10)	µg/L	25	420	T1GW	<25
PHC F2 (>C10-C16)	µg/L	50	150	T1GW	<50
PHC F3 (>C16-C34)	µg/L	400	500	T1GW	<400
PHC F4 (>C34-C50)	µg/L	400	500	T1GW	<400

Reg 153 - Liquid: Reg 153 - Liquid
T1GW: R153 Tbl. 1 - GW

Christine Burke
Laboratory Manager

Appendix E:
Dewatering Estimates

TATHAM ENGINEERING

Estimate

Construction Dewatering Rate
Dupuit - Linear Flow

Zone 1: Site Servicing

$$Q = Kx\frac{H^2 - h^2}{L_0}$$

Ground Elevation		209	m asl	Lowest Proposed Elevation
Highest Groundwater Elevation		208.4	m asl	BH1 on Dec 6, 2023
Lowest Proposed Excavation		206	m asl	Assume 3m below ground surface
Target Water Level		205	m asl	Assume 1 m of drawdown
Aquifer Bottom		205	m asl	
Hydraulic Conductivity	K	5.00E-08	m/s	
Length of Excavation	x	100	m	Per 100 m section
Width of Excavation	a	3	m	
Calculated Parameters				
Water level above aquifer bottom	H	3.4	m	
Target water level above aquifer bottom	h	0	m	
Radius of Influence	R_0	2	m	
Length of Influence (L_0=R_0/2)	L_0	1	m	
Precipitation		3,000	L/day	
Construction Dewatering Flow Rate - Steady State	Q	**4,400**	L/day	Per 100 m section
Maximum Construction Dewatering Flow Rate (safety factor of 2)	2Q	**8,800**	L/day	Per 100 m section
Maximum Construction Dewatering Flow Rate (safety factor of 2) with 10 mm rainfall event	2Q	**11,800**	L/day	Per 100 m section

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Construction Dewatering Rate Estimate
Dupuit-Forcheimer - Radial Flow

Zone 1: Stormwater Management Block

$$Q = \frac{\pi K(H^2 - {h_w}^2)}{In\frac{R_0}{r_e}} + 2\frac{xK(H^2 - {h_w}^2)}{L}$$

Ground Elevation		209	m asl	Lowest Proposed Elevation
Highest Groundwater Elevation		208.4	m asl	BH1 on Dec 6, 2023
Lowest Proposed Excavation		206.9	m asl	
Target Water Level		205.9	m asl	Assume 1 m of drawdown
Aquifer Bottom		205.9	m asl	
Hydraulic Conductivity	K	5.00E-08	m/s	
Length of Excavation	x	67	m	Total Area = 0.45 ha
Width of Excavation	a	67	m	
Calculated Parameters				
Water level above aquifer bottom	H	2.5	m	
Target water level above aquifer bottom	h	0	m	
Radius of Influence	R_0	39	m	$R_0<r_e$, $R_0=r_e+3000(H-h_w)K^{0.5}$
Equivalent Radius (re=(a*x)/π)^0.5)	r_e	38	m	
Length of Influence ($L_0=R_0/2$)	L_0	20	m	
Precipitation		44,890	L/day	Assume 10 mm rain event
Construction Dewatering Flow Rate - Steady State	Q	**2,000**	L/day	
Maximum Construction Dewatering Flow Rate (safety factor of 2)	2Q	**4,000**	L/day	
Maximum Construction Dewatering Flow Rate (safety factor of 2) with 10 mm rainfall event per 100 m	2Q	**48,890**	L/day	

Appendix F:
Water Balance

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Water Budget

Project Details

412 Miller Street, Meaford Onta	122076

Prepared By

KG	December 15, 2023

Water Balance Detials

Methodology	Thornthwaite Method
Climate Data & Source	Thornbury Slama Climate Normal Data for 1981 to 2010 (Environment Canada)
Thornthwaite Coefficient	1.056

Month	Temp (°C)	Precip (mm)	Heat Index	PET (mm)	Daylight Factor	Days	Adjusted PET (mm)	Surplus (mm)	Deficit (mm)
Jan.	-6.3	100.0	0.0	0.0	0.77	31	0.0	100.0	0.0
Feb.	-5.4	68.4	0.0	0.0	0.87	28	0.0	68.4	0.0
Mar.	-1.5	64.0	0.0	0.0	1.00	31	0.0	64.0	0.0
Apr.	5.5	65.3	1.2	28.9	1.12	30	32.5	32.8	0.0
May	11.5	82.7	3.5	71.4	1.23	31	88.0	0.0	5.3
Jun.	16.7	79.1	6.2	107.1	1.29	30	138.1	0.0	59.0
Jul.	19.8	72.1	8.0	129.6	1.26	31	163.5	0.0	91.4
Aug.	19.2	78.2	7.7	115.9	1.17	31	135.1	0.0	56.9
Sep.	15.5	95.9	5.5	80.0	1.04	30	83.4	12.5	0.0
Oct.	9.1	87.3	2.5	41.4	0.92	31	37.9	49.4	0.0
Nov.	3.1	99.6	0.5	11.3	0.80	30	9.0	90.6	0.0
Dec.	-2.7	99.4	0.0	0.0	0.74	31	0.0	99.4	0.0
Total	**-**	**992**	**35.1**	**585.4**	**-**	**365**	**687.5**	**517.1**	**212.6**

Additional Notes

PET = Potential Evapotranspiration;

Equations

$PET = 16\left(\frac{L}{12}\right)\left(\frac{N}{30}\right)\left(\frac{10T_d}{I}\right)^{\alpha}$ Where

PET is the estimated potential evapotranspiration (mm/month)

T_d is the average daily temperature (degrees Celsius; if this is negative, use 0) of the month being calculated

N is the number of days in the month being calculated

L is the average day length (hours) of the month being calculated

$\alpha = (6.75 \times 10^{-7})I^3 - (7.71 \times 10^{-5})I^2 + (1.792 \times 10^{-2})I + 0.49239$

$I = \sum_{i=1}^{12}\left(\frac{T_{m_i}}{5}\right)^{1.514}$ is a heat index which depends on the 12 monthly mean temperatures T_{m_i}.[1]

TATHAM ENGINEERING

Water Budget

Project Details

412 Miller Street, Meaford	122076

Prepared By

KG	12/15/2023

Pre-Development Catchment Details

Area (ha)	7.01
Pervious Area (ha)	7.01
Impervious Area (ha)	0.00

Post Development Catchment Details

Area (ha)	7.01
Pervious Area (ha)	3.35
Impervious Area (ha)[1]	3.66

Infiltration Factor	Pre-Development			Post Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Topography	0.300	0.0		0.300	0.0	
Soil	0.200	0.0		0.200	0.0	
Land Cover	0.100	0.0		0.100	0.0	
Infiltration Factor	0.600	0.0		0.600	0.0	

Water Budget	Pervious	Impervious	Total	Pervious	Impervious	Total
Water Surplus (m^3)	36,250	0	36,250	17,325	18,925	36,250
Infiltration (m^3)	21,750	0	21,750	10,395	0	10,395
Runoff (m^3)	14,500	0	14,500	6,930	18,925	25,855
Reduction in Infiltration Volume (m^3)						**11,355**
Reduction in Infiltration Volume (%)						**52.2**

Additional Notes

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

(Stormwater Planning and Design Manual. MOE, 2003.)