Hydrogeological Assessment
D-5-4 Nitrate Impact Study

Peter O'Donnell
Feairs Drive Lot Development
Township of Southgate
Grey County

R.J. Burnside & Associates Limited
449 Josephine Street P.O. Box 10
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December 2021
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Distribution List

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Revision	Date	Description
0	December 10, 2021	Initial Submission to Mr. O'Donnell

R.J. Burnside & Associates Limited

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Report Reviewed By:

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Project Engineer
KH:tp

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Disclaimer

1.0 Introduction

Mr. Peter O'Donnell (the "Proponent") is applying to create new lots on an approximately 2.82 ha (7 acres) parcel of land (the "Site") in Cedarville, Ontario (see Figure 1). The property is zoned Agricultural – Restricted (A2) and the area has no municipal services. Therefore, the lots would be serviced by a private well(s) and on-Site sewage systems.

As part of the development approval process, R.J. Burnside & Associates Limited (Burnside) was retained to complete a Hydrogeological Assessment to characterize the geological conditions of the Site and assess the potential for nitrate impacts from wastewater effluent on local groundwater receptors.

The work was completed in accordance with the Ministry of the Environment, Conservation and Parks (MECP) 1995 "Hydrogeological Technical Information Requirements for Land Development Applications" and the MECP 1996 Procedure D-5-4 "Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment".

1.1 Scope of Work

The scope of work completed as part of this Hydrogeological Assessment included:

- A review of available background information including:
  - MECP water well records;
  - Geological and soils mapping;
  - Source Protection Area Assessment Report.
- Excavation of eight test pits on the Site to examine sub-surface conditions;
- Submission of two soil samples for grain size analysis;
- Calculation of percolation times; and
- Assessment, interpretation and reporting of the results.

1.2 Site Location

The Site is located at civic address 150 Feairs Drive, Conn in the Township of Southgate. Figures 1 and 2 illustrate the Site location.

The rectangular shaped Site fronts both sides of Feairs Drive between the existing houses and Grey Road #14. The Site is currently used for agricultural purposes. The east and west Site limits are bordered by agricultural land. Residential developments are present north and south of the Site and south along Feairs Drive. The northeast end of the Site is bound by a municipal drain.

2.0 Physical Setting

2.1 Topography and Drainage

The regional topography surrounding the Site generally flat, with gentle gradients west towards the South Saugeen River (River) (Figure 2). The drain flows east to west along the north boundary of the Site.

The Site is relatively flat, the east side gently slopes north toward the drain. The ground surface on the west portion of the Site is gently sloping with surface drainage to the west, toward the river (Figure 2). The surface elevation ranges from roughly 465 m above sea level (asl) on the Site to 463 m asl at the River. The drain flows west from the north side of the property and connects to the River approximately 300 m downstream.

2.2 Environmental Features

Existing waterbodies and wetlands near the Site are shown on Figure 2 delineating the Saugeen Valley Conservation Authority (SVCA) regulated areas and Natural Environment zones. Along the north property boundary on the east side of the Site there is a small SVCA regulated area that is zoned Environmental Protection (EP) creating a buffer around the drain.

2.3 Geology

2.3.1 Surficial Geology

The Soil Survey of Grey County shows the Site soils to be Listowel silt loam. The Listowel parent material is a medium-textured till described as smooth, gently sloping with imperfect drainage. This is consistent with surficial geology mapping (see Figure 4) that indicates the Site is underlain by a clay to silt-textured till.

Durham bedrock topography mapping indicates the bedrock below the Site is at 450 m asl, suggesting approximately 15 m of overburden.

The MECP water well database identifies 19 water well records within 300 m of the Site. The information for all nearby bedrock wells is summarized in Appendix A and the locations are shown on the MECP Well Locations (see Figure 3).

All 19 water well records (WWR) report clay and/or hardpan at surface to a depth between 8 and 20 m (interpreted as till). Three wells report sand and/or gravel layers within the till, and an additional three report gravel below the till. A limestone bedrock reportedly underlies the till; occurring at 8 to 20 m below ground surface (bgs). One water well record (#2503822) did not report reaching bedrock and was completed in a sand and gravel with boulders at 15 m bgs.

2.3.2 Bedrock Geology

The local bedrock is composed of sandstone, shale, dolostone and siltstone of the Guelph Formation. The nearby MECP Water Well Records indicated that the bedrock surface was encountered from 4 to 20 m bgs. Bedrock geology of the area is illustrated on Figure 5.

2.3.3 Site Soils

On November 11, 2021, Burnside observed the excavation of eight test pits on the Site. The test pits ranged in depth from 1.2 to 1.9 m bgs across the Site. Test pit logs are included in Appendix B and the approximate locations are shown on Figure 6.

The test pits encountered 0.3 m of topsoil at ground surface. Most test pits, (except TP6 and TP8) had silt and sand soil beneath the topsoil to depths between 0.6 and 0.8 m bgs. The underlying soil is a clayey silt till with some sand and trace gravel/cobbles. TP1, TP4, TP5 and TP6 were completed in this unit. The remaining test pits (TP2, TP3, TP7 and TP8) end in a softer silt and sand soil, typically at the south end of the Site.

Soil samples were collected from each test pit and two representative samples were submitted to Chung & Vander Doelen Engineering Ltd. for grain size analysis. The results are provided in Appendix C and are summarized below in Table 1.

Table 1: Summary of Grain Size Analysis

Location	Depth (m)	Gravel (%)	Sand (%)	Silt/Clay (%)	Type of Material
TP3	0.9	0.6	18.0	81.1	Clayey Silt, some sand, trace gravel
TP8	1.0	4.1	41.5	50.7	Silt and Sand, trace clay and gravel

The analysis shows the proportions of sand and silt in the submitted samples vary considerably. These natural variations in the Site soils account for differing field descriptions in the test pit logs. The grain size analysis represents the range of soils encountered on-Site.

2.4 Groundwater Conditions

On the east side of the Site, groundwater was observed infiltrating into test pits at roughly 0.9 m bgs. On the west side of the Site, no water seepage was observed in the test pits. Test pits excavated at the southwest end of the Site encountered a saturated silt and sand roughly 1.5 m bgs. Based on local topography (Figure 2) the shallow groundwater at the Site likely flows in a westerly direction, toward the municipal drain.

According to Source Protection mapping, the Site is not located in a well head protection area (WHPA), highly vulnerable Aquifer (HVA) or a significant groundwater recharge area (SGRA). An HVA is mapped beyond the northern Site boundary (municipal drain). Local groundwater supplies and resources are discussed further in Section 5.0.

3.0 Nitrate Impact Assessment

The proponent is planning to service the development with individual on-Site sewage disposal systems. To examine the effects of the proposed sewage systems, Burnside completed a Nitrate Impact Assessment in accordance with the MECP's 1996 Procedure D-5-4. The MECP's procedure involves the following three steps:

1. Lot Size
2. System Isolation
3. Contaminant Attenuation

3.1 Step One – Lot Size Considerations

Procedure D-5-4 indicates that a hydrogeological assessment may not be required for developments consisting of lots greater than one hectare, if it can be demonstrated that the area is not hydrogeologically sensitive. In this case, the proposed lots will be less than one hectare. Therefore, the assessment continues to Step Two.

3.2 Step Two – System Isolation Considerations

Developments can be considered low risk where it can be demonstrated that sewage effluent is hydrogeologically isolated from existing or potential supply aquifers. Given the fine-grained nature of the surficial soils, overburden thickness and source protection mapping, there is potential for aquifer isolation. However, a review of nearby WWRs identified local use of a shallow overburden well as a water supply (#2503822). Therefore, it cannot be demonstrated that sewage effluent will be hydrogeologically isolated from existing or potential supply aquifers. Therefore, the nitrate impact of on-Site sewage systems will depend on Step Three. Water supply considerations are discussed further in Section 5.0, and a WWRs summary is included in Appendix A.

3.3 Step Three – Contaminant Attenuation Considerations

Since it cannot be definitively demonstrated that the sewage effluent is hydrogeologically isolated from all or potential supply aquifers, a predictive assessment (residential developments) was completed.

Sewage effluent introduced into the shallow groundwater system is attenuated through several processes, including dilution by precipitation, dilution by groundwater flowing through the Site, and denitrification in the unsaturated soil zone.

Procedure D-5-4 allows for two ways of demonstrating the attenuation capacity of a development. The first involves monitoring nearby existing developments or building developments in phases and monitoring the impact of each phase. This is not always practical for a small development such as this one.

The second method is to predict the attenuation capacity of a development based on:

- Nitrate concentration in the sewage effluent;
- Sewage volume per lot; and
- Dilution provided by rain/snow infiltrating into the soil over the Site.

The nitrate concentration in residential sewage is estimated to be 40 mg/L in Procedure D-5-4. The objective is to dilute the nitrate in the sewage effluent from 40 mg/L going into the bed to less than 10 mg/L at the lot line. Procedure D-5-4 bases this attenuation capacity on the dilution from infiltrating precipitation only. It is assumed that the nitrate concentration of the precipitation is 0.1 mg/L.

The volume of effluent for a single-family residence is 1,000 L/day, as established by the MECP in Procedure D-5-4. The volume of infiltrating precipitation is a Site-specific estimation based on the soil moisture available and the runoff/infiltration factors of the Site.

The amount of infiltration into the Site soils depends on available surplus (precipitation minus the evapotranspiration), the topography, the soil type and the vegetative cover. The thirty-year climate normals (1981 to 2010) for the Environment Canada station at Durham indicate annual precipitation of 1,119 mm per year. This is the closest station with 30-year normals, approximately 23 km northwest of the Site.

The evapotranspiration was calculated using the Thornthwaite-Mather method resulting in an actual evapotranspiration rate of 557 mm per year for a silt loam. Soil moisture was based on shallow-rooted vegetation (grass). The surplus water remaining for runoff and infiltration calculated to be 562 mm.

Infiltration depends on Site topography, soil type and cover. The infiltration factor for this Site was estimated to be 0.6 (flat topography 0.3, clay/silt soils 0.2 and vegetation cover of predominantly cultivated land 0.1). Multiplying the infiltration factor by the water surplus, results in an infiltration estimate of 337 mm per year. A calculation worksheet illustrating this analysis is provided in Appendix D.

The Site is approximately 7.1 acres. Constructing impermeable surfaces may reduce the area available for infiltration if the runoff from those surfaces is directed off the Site. An impermeable surface area of 250 m^2 per lot has been subtracted from the Site area for the dilution calculation.

Therefore, the inputs for the dilution calculation for 6 lots are:

C = concentration of nitrate after dilution (mg/L)
Q_e = volume of effluent from the leaching bed: (6 units x 365,000 L/yr = 2,190,000 L/yr)
C_e = nitrate concentration in the sewage effluent: (40 mg/L)
Q_p = volume of precipitation infiltrating the Site: (337 mm/yr x 1.97 ha = 6,650,124 L/yr)
C_p = nitrate concentration in the infiltrating precipitation: (0.1 mg/L)

$$C = \frac{Q_e C_e + Q_p C_p}{Q_e + Q_p}$$

$$C = \frac{(2{,}190{,}000 \times 40) + (6{,}650{,}124 \times 0.1)}{2{,}190{,}000 + 6{,}650{,}124}$$

$$C = 9.98 \text{ mg/L}$$

The calculations indicate that the concentration of nitrate will be 9.98 mg/L at the property boundary for 6 lots, with an average lot size of 4,789 m^2. This is less than the MECP's Ontario Drinking Water Quality Standard for nitrate of 10 mg/L. The above calculation is considered highly conservative since it does not consider biological denitrification processes that occur in the unsaturated soils and dilution from sources other than infiltration including grey water discharges, lawn watering and groundwater flow. The actual nitrate loading is anticipated to be well below the calculated concentration.

3.4 Additional Lot Considerations

As the Proponent owns the property being severed to create the lots, there is a potential to add additional lots by increasing the proposed development area. To add one lot, for a total of 7 lots, an additional area of 1.65 acres (total of 8.75 acres) is required for infiltration and dilution. This would extend the proposed development area by 16 m on both the east and west sides and result in an average lot size of 5,060 m^2. To add two lots, for a total of 8 lots, an additional area of 3.4 acres (total of 10.5 acres) is required for infiltration and dilution. This would extend the proposed development area by 32 m on both the east and west sides and result in an average lot size of 5,312 m^2.

4.0 On-Site Sewage Disposal

4.1 Soil Percolation Times

Guidance for estimating percolation times for soils is set out in the Supplementary Standard SB-5 of the 2006 Ontario Building Code. All soil units observed in the test pits were classified according to the Unified Soil Classification System (USCS) based on soil texture. Two soil samples representative of the silt soils were submitted for grain size analysis to assist in classification. The estimate of percolation times (T) for each soil unit was then based on this soil classification plus the observed soil structure, density, plasticity and organic content. The estimated T values are provided in the test pit logs in Appendix B.

The T values for the clayey silt soil encountered across the Site are greater than 50 min/cm. These silt soils are the most common soils identified in the test pits and are typically encountered at 0.8 m bgs. Therefore, they were considered to be the primary soils that will affect bed sizes.

In the southwest corner of the property, the test pit (TP8) encountered silt and sand soil with a reduced clay content at 0.8 m bgs. The T values for the silt and sand soil range from 25 to 35 min/cm. Therefore, there is potential for a reduced bed size where these soils dominate at the southwest corner of the Site.

Due to the variation of site soils, it is recommended that test pits be dug when the location of the sewage disposal bed is confirmed. This will allow an exact site-specific percolation time to be calculated to ensure adequate bed sizing.

4.2 Disposal Bed Size

The area required for a Class 4 on-site sewage system can be calculated based on the potential house size and native soil. Area calculations were based on the typical single family residential home containing four bedrooms and a finished floor area of less than 200 m^2. This resulted in a daily sewage design flow of 2,000 L/day.

Disposal bed sizing will vary due to the variation of T. For calculation purposes, we used a T of greater than 50 min/cm for the areas underlain by the clayey silt soils. The shallow water table observed in test pits on the east side of the Site and the low permeability native soils (T greater than 50 min/cm) are unacceptable for a conventional leaching bed therefore a raised leaching bed will be required. Assuming a T of greater than 50 min/cm, the minimum area required for the bed and mantle is 500 m^2, based on the loading rates prescribed in the Ontario Building Code. Therefore, the area required for a fill-based absorption trench (raised) disposal bed, including mantle and side slopes, for a single family home would be approximately 800 m^2. A sample calculation worksheet is provided in Appendix E.

5.0 Water Supply Considerations

MECP Procedure D-5-5 indicates that water intended for human consumption should not contain any disease-causing organisms or hazardous concentrations of toxic chemicals or radioactive substances. Aesthetic considerations also provide a basis for drinking water objectives since the water should be pleasant to drink. A preliminary assessment of water supply considerations was completed, consisting of a background information review to assess if the local aquifers can supply the proposed development.

Figure 3 illustrates the MECP well record locations near the site. A detailed water well record summary table is provided in Appendix A. Table 2 below summarizes the water well records within 300 m of the Site.

Table 2: MECP Well Record Summary

Well #	Well Depth (m)	Pumping Rate (L/min)	Well Type	Overburden Soil	Depth to Bedrock (m)
2501955	33.2	63.6	Bedrock	Clay/Stone	18.6
2501956	24.1	90.9	Bedrock	Clay/Sand	14.0
2503100	32.9	27.3	Bedrock	Hardpan	14.6
2503822	13.4	27.3	Overburden	Clay/Sand	-
2504051	30.2	27.3	Bedrock	Clay	15.8
2505661	13.7	68.2	Bedrock	Clay/Hardpan	8.2
2505857	27.4	36.4	Bedrock	Clay/Stones	14.9
2507562	28.7	113.7	Bedrock	Hardpan/Clay	18.0
2508007	32.0	68.2	Bedrock	Clay	16.5
2508008	38.1	68.2	Bedrock	Clay/Hardpan	18.3
2508631	23.8	136.4	Bedrock	Clay	5.5
2515014	15.2	54.6	Bedrock	Clay	9.1
2516382	38.1	68.2	Bedrock	Clay/Stone	16.8
2516480	9.1	NA	Abandonment	NA	NA
2516768	10.7	37.0	Bedrock	Clay	3.7
2516865	30.5	45.5	Bedrock	Clay/Stone	17.1
7101769	21.3	45.5	Bedrock	Clay/Stone	13.7
7139116	29.0	18.2	Bedrock	Clay/Gravel	16.2
7141586	35.1	45.5	Bedrock	Clay/Stone	19.8

The above summary indicates the water supply wells are constructed in the bedrock aquifer, except for record #2503100. The depth to bedrock ranged from 4 to 20 m. The recommended pumping rates for the wells ranged from 18.2 L/min to 136.4 L/min, indicating the local bedrock aquifer can supply the proposed development. Actual well yields will need to be confirmed.

Future water supply wells should be installed in the limestone bedrock and constructed as per the requirements of Ontario Regulation 903.

6.0 Conclusions and Recommendations

Based on the information described above we conclude that:

1. The shallow soils at the Site are primarily composed of a clayey silt till. An area at the southwest corner of the Site has sand and silt soils.

2. Step three of MECP Procedure D-5-4 indicates that, with 337 mm of infiltration per year, 6 lots could be accommodated on the Site and still meet the maximum acceptable nitrate concentration of 10 mg/L at the lot line.

3. For 7 lots, the proposed development area requires a total of 8.75 acres to meet the maximum acceptable nitrate concentration.

4. For 8 lots, the proposed development area requires total of 10.5 acres to meet the maximum acceptable nitrate concentration.

5. A percolation time of greater than 50 min/cm, representative of the clayey silt soils, was selected based on a review of the grain size analysis and observations during the test pitting program. These soils are not acceptable for conventional absorption trench disposal beds and require a fill-based (raised) absorption trench disposal bed.

6. The clayey silt soils require a minimum disposal bed and mantle area of 500 m^2 for a typical four bedroom, 200 m^2 single family home. Accounting for side slopes results in an approximately 800 m^2 footprint.

7. Lot grading and drainage and/or stormwater management should attempt to balance pre- and post-development infiltration volumes.

8. Due to the variability in the soils on the site, test pits should be completed for each lot prior to applying for the building permit to select the final bed location.

9. The primary local aquifer is the bedrock aquifer. It is protected from surface activities by approximately 8 to 20 m of overlying fine grained soil.

10. The recommended pumping rates for local water supply wells ranged from 18.2 L/min to 136.4 L/min indicating the local bedrock aquifer can supply the proposed development.

11. The water supply should be verified in accordance with MECP Procedure D-5-5 *Technical Guideline for Private Wells: Water Supply Assessment*

12. Future water supply wells should be installed in the limestone bedrock and constructed as per the requirements of Ontario Regulation 903.

7.0 References

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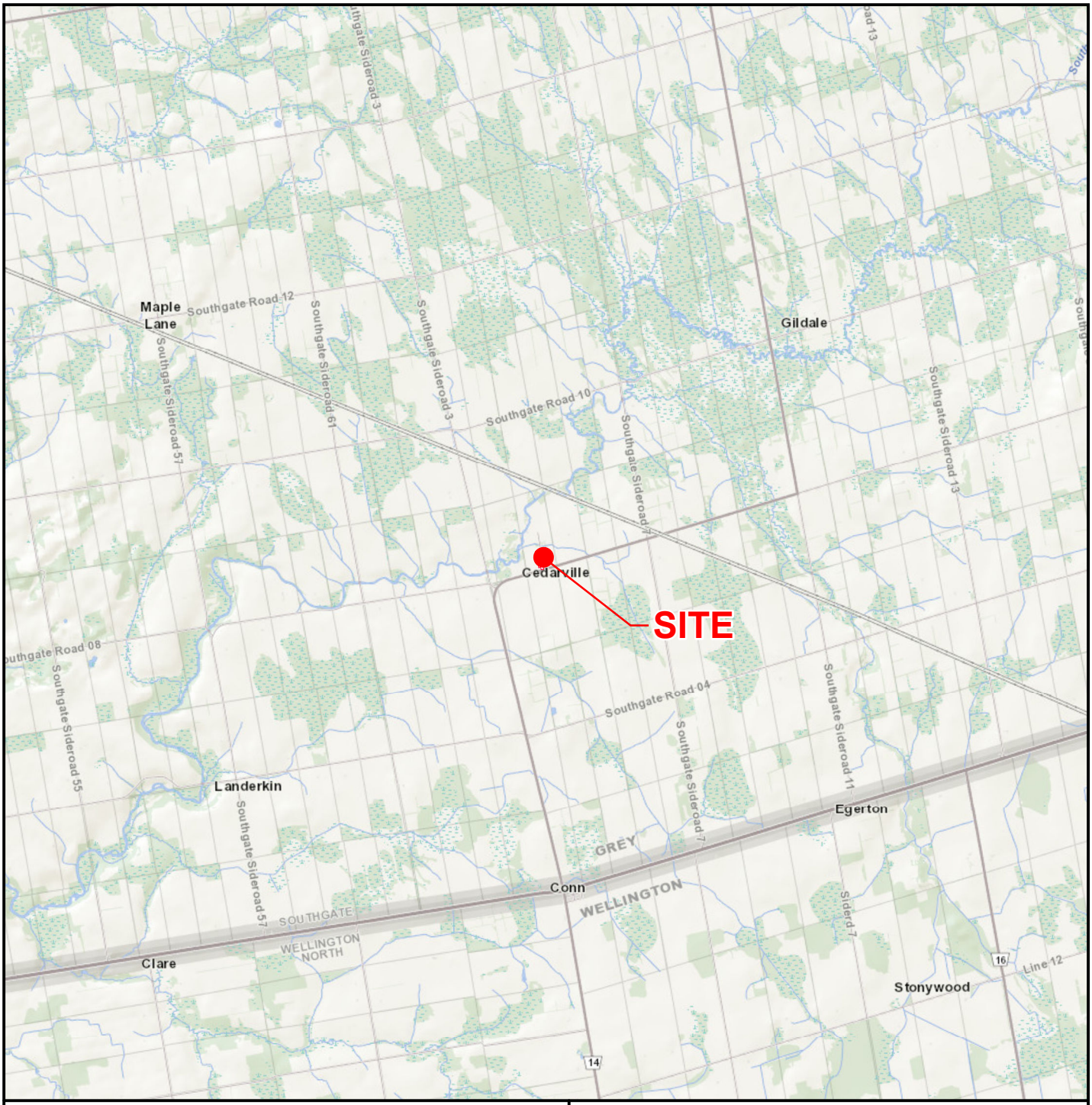
Figures



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Client / Report

PETER O'DONNELL
150 FEAIRS DRIVE
SOUTHGATE, ONTARIO

D 5-4 NITRATE STUDY

Figure Title:

SITE LOCATION

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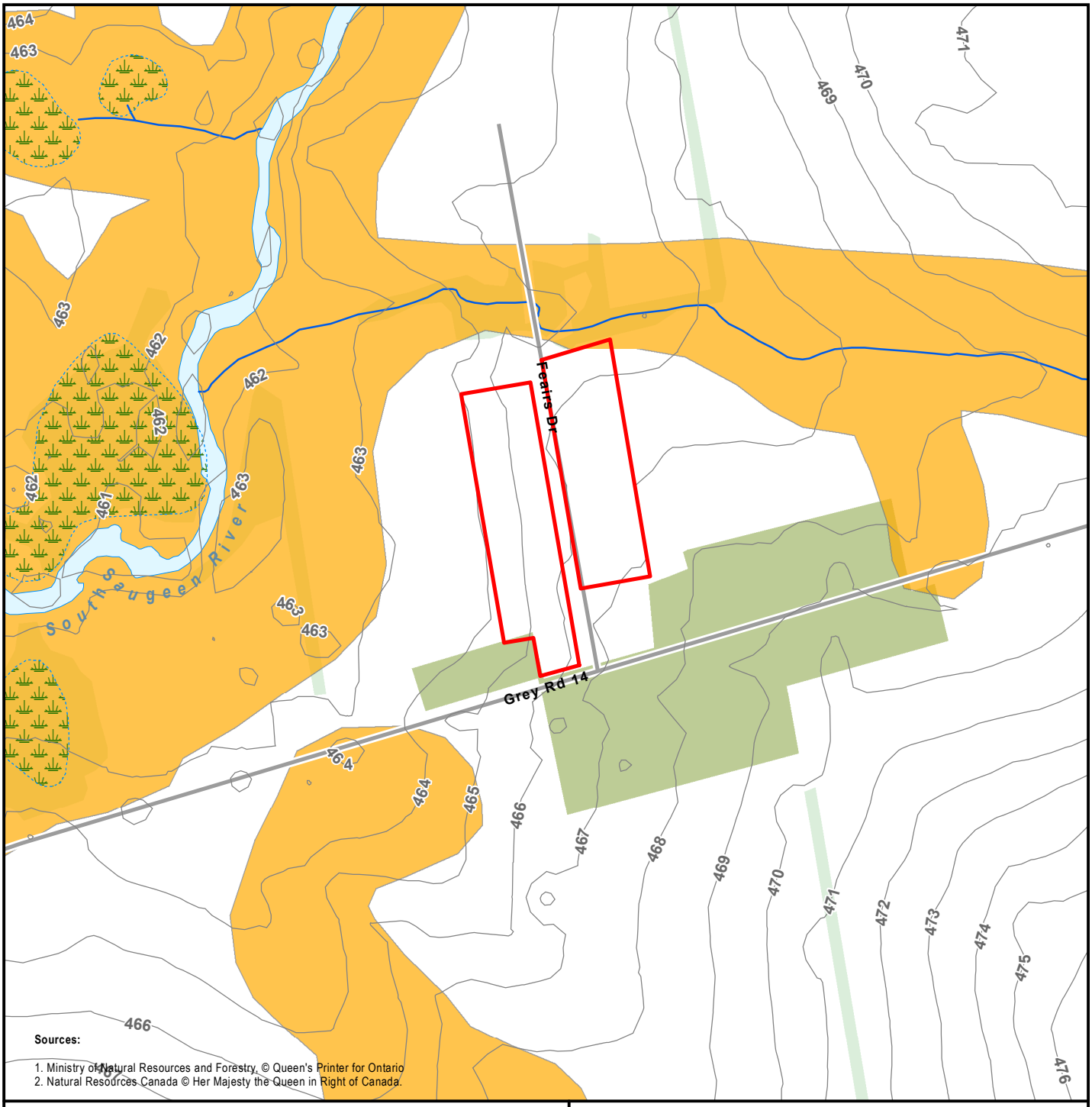

Sources:

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LEGEND

- SUBJECT LANDS
- SVCA REGULATED AREA
- CONTOUR (1m intervals - masl)
- ROADWAY
- WATERCOURSE
- WETLAND
- WOODED AREA
- BUILT-UP AREA: PERVIOUS
- OPEN WATER

0 50 100 200 300
Metres

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Figure Title:

REGULATED AREAS

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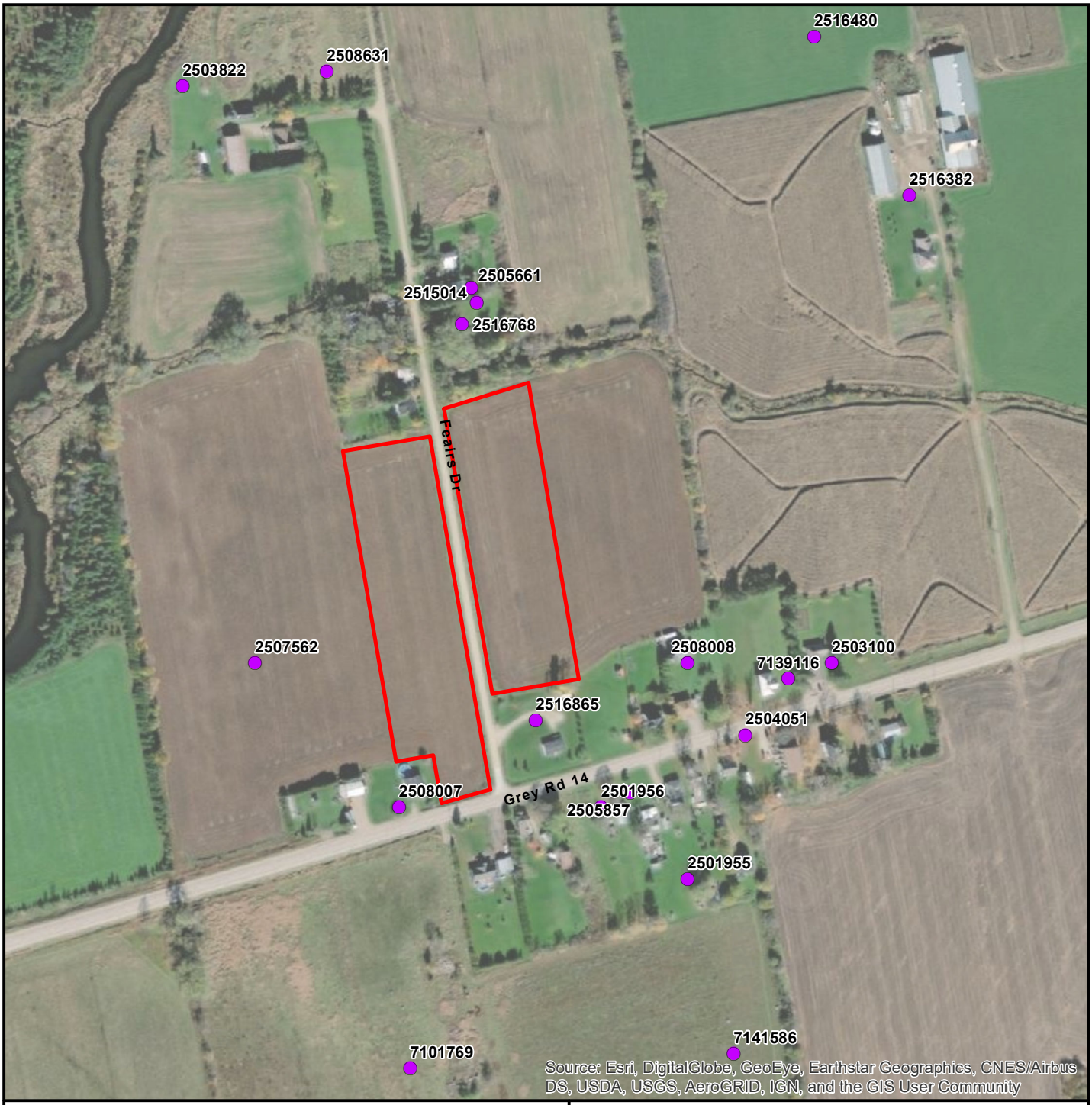

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SUBJECT LANDS

MECP WELL RECORD LOCATION

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Figure Title:

MECP WELL LOCATIONS

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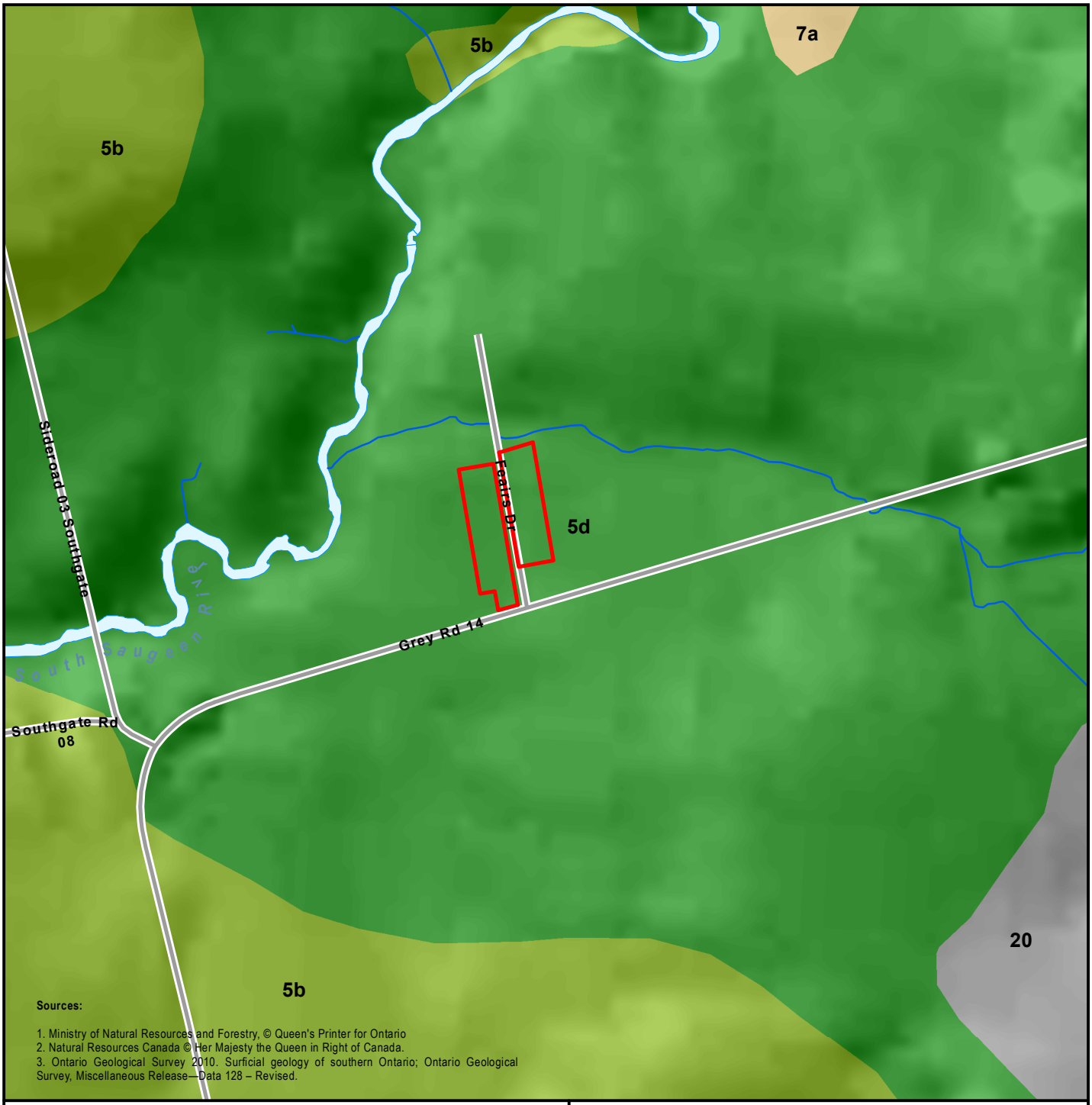

LEGEND

- SUBJECT LANDS
- ROADWAY
- WATERCOURSE
- OPEN WATER
- 5b: Till: Stone-poor, carbonate-derived silty to sandy till
- 5d: Till: Glaciolacustrine-derived silty to clayey till
- 7a: Glaciofluvial deposits: Sandy deposits
- 20: Organic deposits

0 50 100 200 300 400 500 600 700
Metres

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Figure Title:

SURFICIAL GEOLOGY

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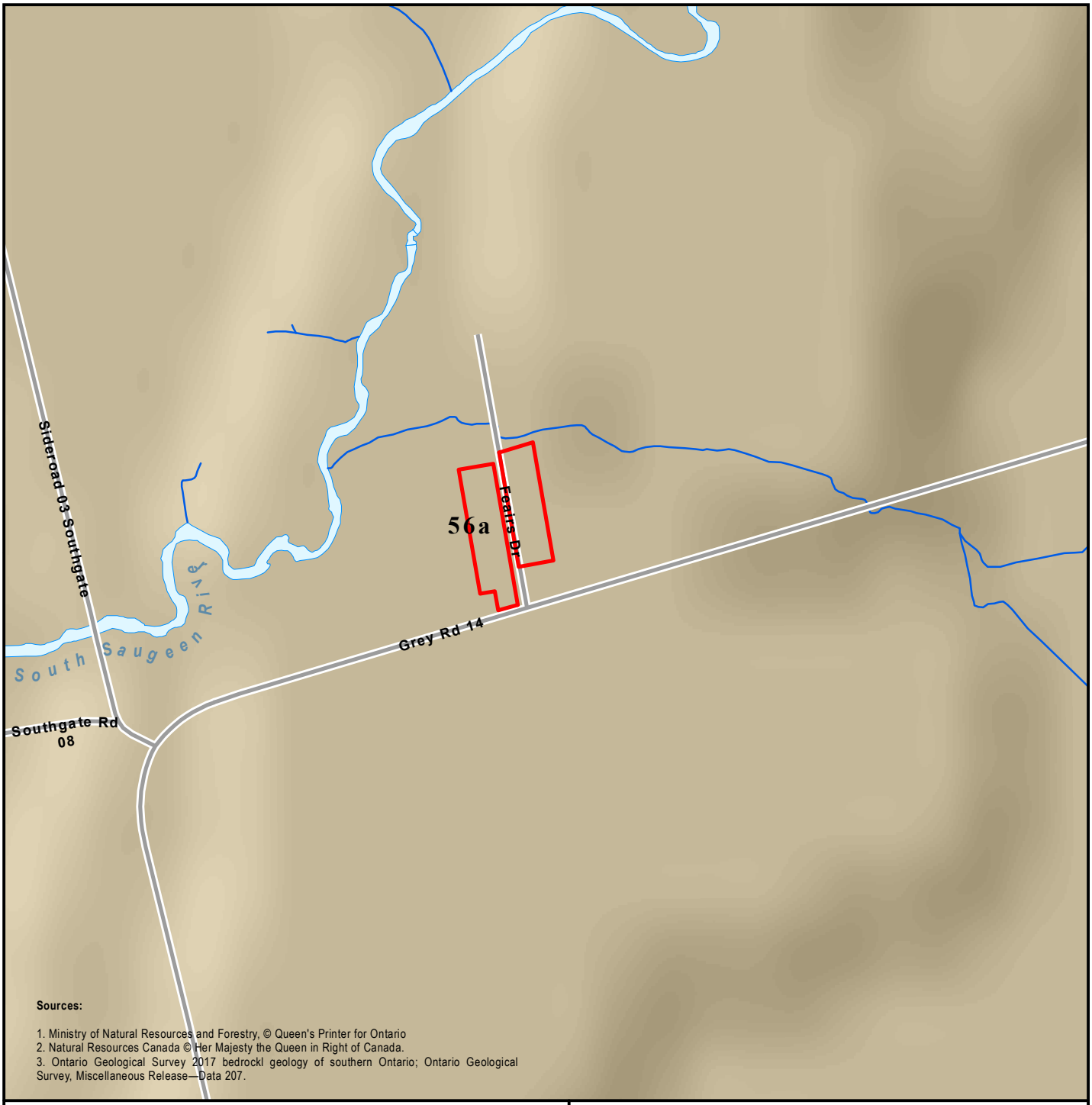

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Ontario Geological Survey 2017 bedrockl geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 207.

LEGEND

- SUBJECT LANDS
- ROADWAY
- WATERCOURSE
- OPEN WATER

LOWER SILURIAN - 56 Sandstone, shale, dolostone, siltstone

- 56a Guelph Fm.

0 50 100 200 300 400 500 600 700
Metres

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Figure Title:

BEDROCK GEOLOGY

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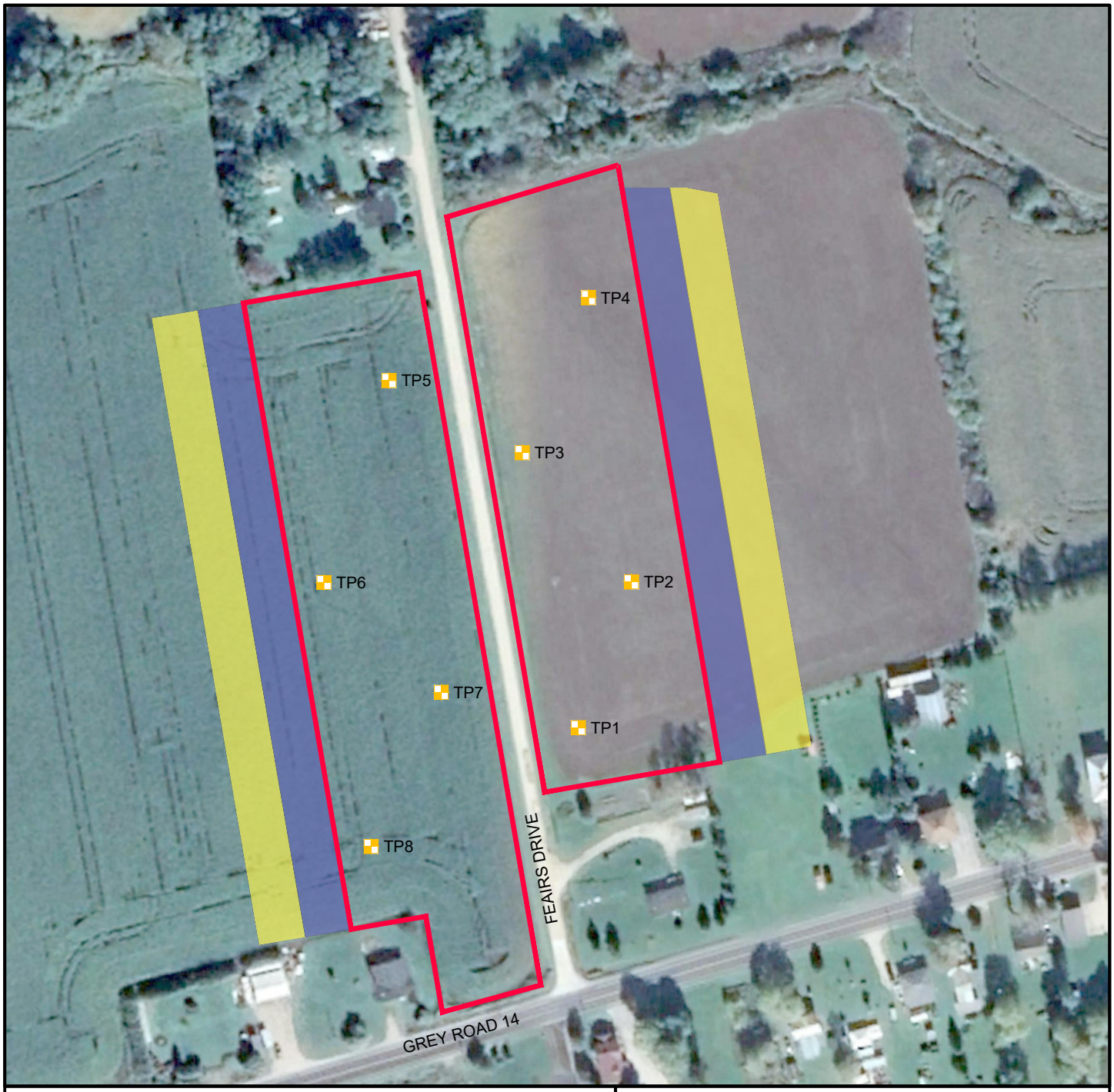

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- SUBJECT LANDS
- WATERCOURSE
- LAND REQUIRED FOR ONE ADDITIONAL LOT
- LAND REQUIRED FOR TWO ADDITIONAL LOTS
- TEST PIT

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Metres

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D 5-4 NITRATE STUDY

Figure Title

SITE PLAN

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Appendix A

MECP Water Well Records Summary

Water Well Records

Tuesday, December 07, 2021
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TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
PROTON TOWNSHIP 016	17 534258 4876258 W	2006/03 7146		FR 0032	1/5/83/1:0	DO		2516768 (Z42536) A017594	BRWN LOAM CLAY 0002 BRWN CLAY STNS 0012 BRWN LMSN 0030 GREY LMSN 0035
PROTON TOWNSHIP 05 003	17 534309 4875983 W	2006/06 6634	6	0100	0/55/20/2:	DO		2516865 (Z48372) A043249	LOAM 0002 CLAY STNS 0056 LMSN HARD 0100
PROTON TOWNSHIP 05 004	17 534222 4875742 W	2007/11 6634	6	FR 0070	4/32/10/1:30	DO		7101769 (Z69649) A062815	LOAM 0001 CLAY STNS 0045 LMSN 0070
PROTON TOWNSHIP 05 005	17 534502 4876457 W	2005/07 6634						2516480 (Z32560) A021072 A	
PROTON TOWNSHIP 05 005	17 534568 4876347 W	2005/04 6634	6	0125	3/26/10/1:	ST		2516382 (Z21332) A019477	LOAM 0001 CLAY STNS 0055 LMSN HARD 0125
PROTON TOWNSHIP CON 04 004	17 534214 4875923 W	1983/09 3740	4	FR 0105	3/12/15/15:0	DO		2508007 ()	BRWN CLAY STNS 0016 BRWN CLAY GRVL 0045 BRWN CLAY SAND 0054 GREY LMSN 0090 BRWN LMSN SHLE 0105
PROTON TOWNSHIP CON 04 004	17 534354 4875923 W	1964/02 1804	4 4	FR 0050	0/5/20/4:0	DO		2501956 ()	LOAM 0002 CLAY 0020 MSND 0030 CLAY 0040 MSND 0046 GREY ROCK 0079
PROTON TOWNSHIP CON 04 004	17 534446 4875752 W	2009/07 6634	6	FR 0115	5/25/12/24:0	DO		7141586 (Z102121) A079534	LOAM 0002 CLAY STNS 0065 LMSN SHLE 0115
PROTON TOWNSHIP CON 04 004	17 534414 4875873 W	1958/08 1723	4 4	FR 0107	7/12/14/4:0	DO		2501955 ()	CLAY STNS 0061 GREY ROCK 0109
PROTON TOWNSHIP CON 04 004	17 534454 4875973 W	1972/11 3029	4	FR 0090 FR 0099	2/20/8/2:0	DO		2504051 ()	PRDG 0016 BRWN CLAY GRVL 0042 BRWN CLAY SAND 0052 BRWN ROCK 0099
PROTON TOWNSHIP CON 04 004	17 534374 4875933 W	1976/10 3740	4	FR 0090	4/25/10/1:0	DO		2505857 ()	BLCK LOAM 0001 BRWN CLAY STNS 0049 GREY LMSN 0090
PROTON TOWNSHIP CON 04 005	17 534514 4876023 W	1969/11 1705	4	FR 0108	3/18/10/1:15	DO		2503100 ()	LOAM 0001 BRWN HPAN GRVL STNS 0039 GRVL MSND 0048 BRWN ROCK 0052 BRWN SHLE 0061 GREY ROCK 0108
PROTON TOWNSHIP CON 05 004	17 534064 4876423 W	1972/06 1737	4	FR 0045 FR 0050	///:	ST		2503822 ()	LOAM FILL 0001 BRWN CLAY 0011 BLUE CLAY 0022 BLUE CLAY STNS 0029 SAND GRVL BLDR 0050
PROTON TOWNSHIP CON 05 004	17 534264 4876283 W	1975/06 4856	4	FR	//5/:	DO		2505661 ()	BLCK LOAM 0001 BRWN CLAY 0013 BRWN HPAN BLDR 0027 WHIT LMSN 0045
PROTON TOWNSHIP CON 05 004	17 534114 4876023 W	1981/07 3740	4	FR 0094	3/11/30/1:0	DO		2507562 ()	BRWN CLAY STNS 0019 GREY HPAN GRVL 0042 BRWN GRVL 0056 GREY CLAY SAND 0059 GREY LMSN 0094
PROTON TOWNSHIP CON 05 004	17 534164 4876433 W	1986/06 3813	5	FR 0078	4/8/30/3:0	DO		2508631 (NA)	CLAY GRVL 0018 LMSN 0078

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
PROTON TOWNSHIP CON 05 004	17 534268 4876273 W	2002/06 6634	6	FR 0050	1/15/25/2:0	DO		2515014 (246616)	LOAM 0002 CLAY STNS 0030 BRWN LMSN HARD 0050
PROTON TOWNSHIP CON 05 005	17 534484 4876012 W	2009/11 2576	6 6	FR 0063 FR 0092	1//4/1:0	DO		7139116 (Z102009) A088823	LOAM 0002 BRWN CLAY GRVL 0015 BRWN GRVL SAND WBRG 0017 GREY CLAY GRVL 0029 BRWN CLAY GRVL 0053 WHIT LMSN 0077 GREN SHLE 0078 BRWN LMSN 0095
PROTON TOWNSHIP CON 05 005	17 534414 4876023 W	1983/09 3740	4	FR 0125	3/18/15/1:0	DO		2508008 ()	BRWN CLAY STNS 0015 GREY HPAN GRVL 0060 GREY LMSN 0110 BRWN LMSN 0125

Notes:
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 Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
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

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
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		

2. Core Color

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

3. Well Use

Code	Description	Code	Description
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		

4. Water Detail

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

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Appendix B

Test Pit Logs

Test Pit Logs

Test Pit No	Depth Interval	Soil Description	Soil Sample No.	Soil Sample Depth	Unified Soil Classification	Percolation Time [1] min/cm	Groundwater
TP 1	UTM	17T 534290mE 4876024mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.80	Brown SILT and SAND, trace gravel and cobbles; massive; firm; cohesive; non-plastic; moist; iron-stained	S1	0.60	ML	30 - 40	
	0.80 - 1.50	Grey clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S2	1.00	CL	>50	Groundwater infiltrating at 0.9 m bgs
TP 2	UTM	17T 534308mE 4876073mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.60	Brown SILT and SAND, trace clay and gravel; massive; firm; cohesive; non-plastic; moist; iron-stained	S1	0.50	ML	30 - 40	
	0.60 - 1.00	Grey clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S2	1.00	CL	>50	Groundwater infiltrating at 1.0m bgs
	1.00 - 1.40	Light brown SILT and SAND, some clay, trace gravel; massive; soft; cohesive; low plasticity; saturated	S3	1.20	ML	25 - 35	Standing water at base of test pit
TP 3	UTM	17T 534271mE 4876118mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.60	Brown SILT and SAND, trace clay and gravel; massive; firm; cohesive; non-plastic; moist; iron-stained	S1	0.50	ML	30 - 40	
	0.60 - 1.60	Grey clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S2	0.90 [2]	CL	>50	
	1.60 - 1.90	Light brown SILT and SAND, trace clay and gravel; massive; soft; cohesive; non-plastic; wet to saturated	S3	1.80	ML	25 - 35	No groundwater observed
TP 4	UTM	17T 534294mE 4876171mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.60	Brown SILT and SAND, trace clay and gravel; massive; firm; cohesive; non-plastic; moist; iron-stained	S1	0.50	ML	30 - 40	
	0.60 - 1.20	Grey clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S2	1.00	CL	>50	Groundwater infiltrating at 0.9 m bgs

Test Pit Logs

Test Pit No	Depth Interval	Soil Description	Soil Sample No.	Soil Sample Depth	Unified Soil Classification	Percolation Time [1] min/cm	Groundwater
TP 5	UTM	17T 534225mE 4876143mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.60	Brown SILT and SAND, trace clay and gravel; massive; firm; cohesive; non-plastic; moist; iron-stained	S1	0.40	ML	30 - 40	
	0.60 - 1.00	Brown clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S2	0.90	CL	>50	
	1.00 - 1.80	Grey clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S3	1.20	CL	>50	No groundwater observed
TP 6	UTM	17T 534203mE 4876073mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 1.90	Brown clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; non-plastic; wet; iron-stained	S1	0.80	ML	40 - 50	No groundwater observed
TP 7	UTM	17T 534243mE 4876035mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.60	Brown SILT and SAND, trace clay and gravel; massive; firm; cohesive; non-plastic; moist; iron-stained	S1	0.40	ML	30 - 40	
	0.60 - 1.00	Brown clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S2	0.80	CL	>50	
	1.00 - 1.50	Grey clayey SILT, some sand, trace gravel; massive; stiff; cohesive; low plasticity; wet; iron-stained	S3	1.20	CL	>50	
	1.50 - 1.80	Light grey SILT and SAND, trace clay and gravel; massive; soft; cohesive; non-plastic; wet to saturated	S4	1.70	ML	25 - 35	No groundwater observed
TP 8	UTM	17T 534218mE 4875983mN					
	0 - 0.30	Dark brown sandy SILT, with organics (topsoil)					
	0.30 - 0.70	Brown clayey SILT, some sand, trace gravel; massive; very stiff; cohesive; low plasticity; wet; iron-stained	S1	0.50	CL	>50	
	0.70 - 1.50	Light grey SILT and SAND, trace clay and gravel; massive; soft; cohesive; non-plastic; wet to saturated	S2	1.00 [2]	ML	25 - 35	No groundwater observed

Logged on November 15, 2021 by A. Maenza

[1] - Percolation time estimated from soil description and lab tests.

[2] - Sample selected for grain size analysis.

All measurements are in metres unless otherwise indicated.

Soil samples will be retained for three months from date of report.

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Appendix C

Grain Size Analysis

CHUNG & VANDER DOELEN
ENGINEERING LTD.

311 VICTORIA STREET NORTH
KITCHENER / ONTARIO / N2H 5E1
519-742-8979

November 24, 2021
File: M21014

Attn: Alex Maenza
R.J. Burnside & Associates Limited
449 Josephine Street, PO Box 10
Wingham, Ontario N0G 2W0

RE: Grain Size Analysis Test Result
Soil Analysis – Southgate D-5-4 (No. 300054349.0000)

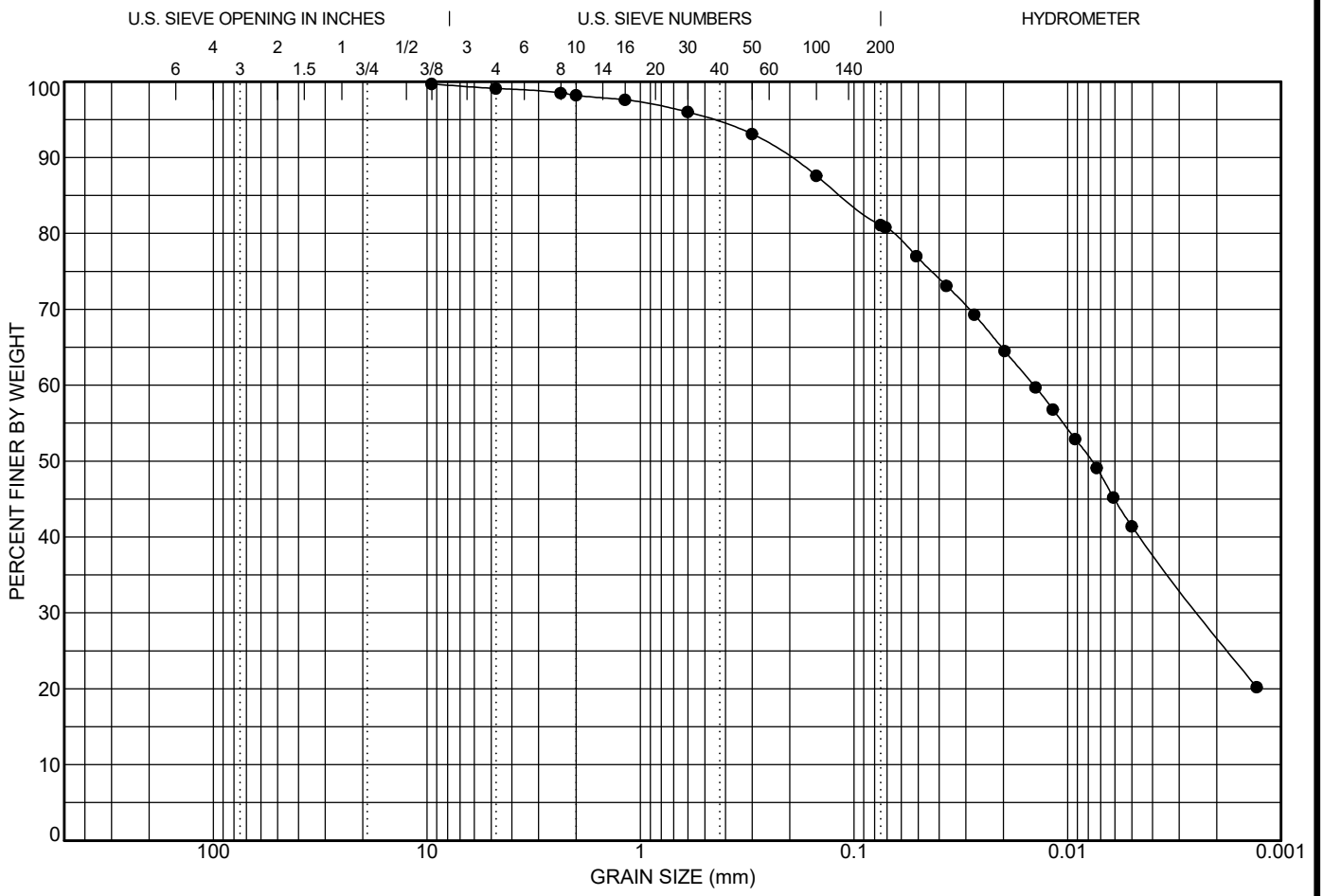
Chung & Vander Doelen Engineering Ltd. (CVD) is pleased to submit two (2) enclosed grain size analysis test results for the above noted project.

Should you have any questions, please contact our office at your convenience.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.

Hugh Arthur
Laboratory Supervisor

Andrew LeDrew, C.E.T., BSS
Team Manager, Inspection & Materials Testing



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					9.5	0.014	0.002		0.6	18.0	81.1	

Date: Nov. 24 - 2021
Client: R.J. Burnside & Associates Limited
Contractor: N/A
Source: TP3
Sampled From: 0.9 m
Sample No.: S2
Date Sampled: N/A
Sampled By: Client
Lab No.: 1435
Date Tested: Nov. 25 - 2021
Type of Material: Clayey Silt, some Sand, trace Gravel

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

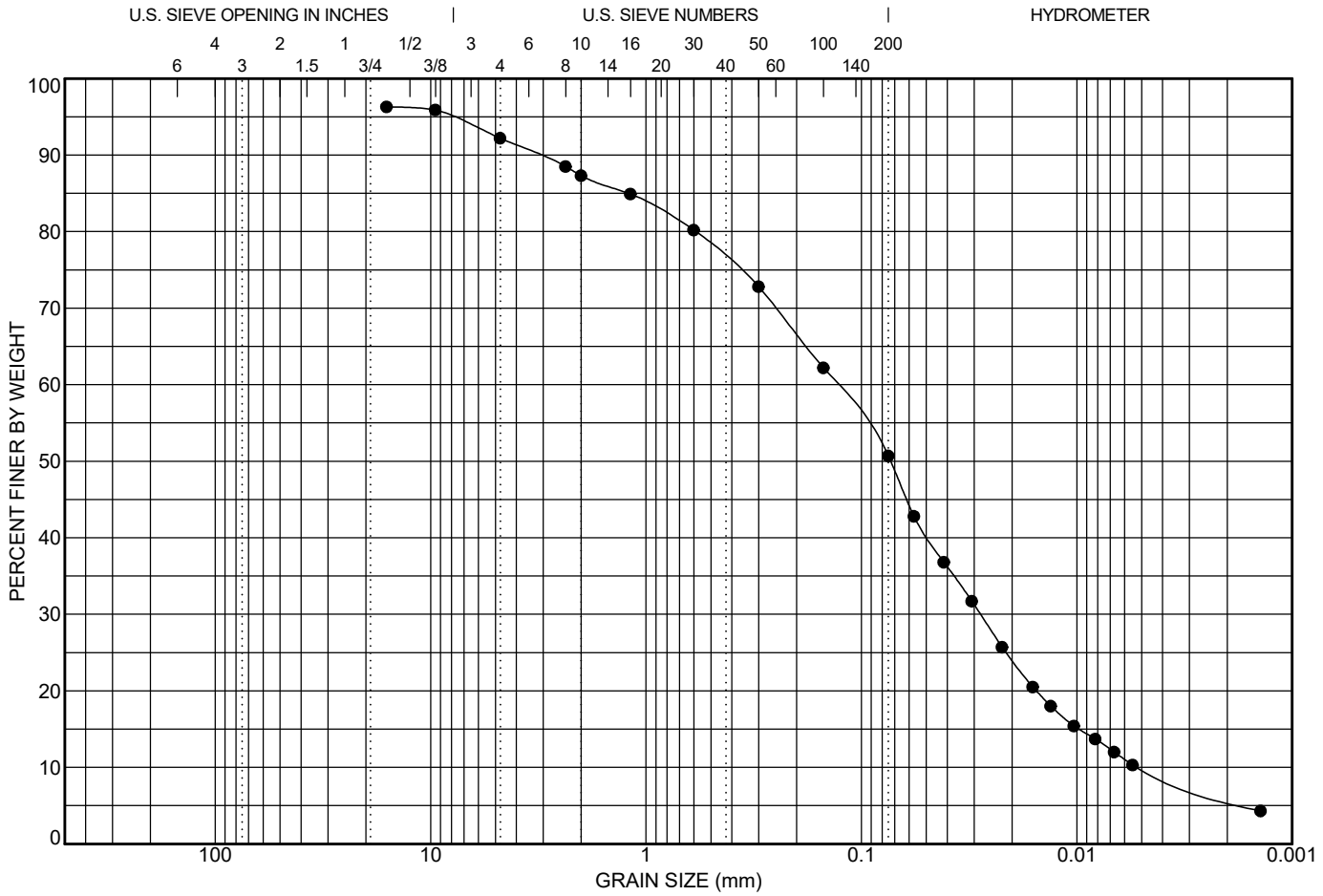
Project: Southgate D-5-4

Location: N/A

File No.: M21013

Enclosure No.: 1

DM - NO SPECIFICATIONS M21013 - WINGHAM-SOUTHGATE D-5-4.GPJ LAW LNDN.GDT 21-11-24



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			1.16	25.58	16	0.131	0.028	0.005	4.1	41.5	50.7	

Date: Nov. 24 - 2021
Client: R.J. Burnside & Associates Limited
Contractor: N/A
Source: TP8
Sampled From: 1.0 m
Sample No.: S2
Date Sampled: N/A
Sampled By: Client
Lab No.: 1436
Date Tested: Nov. 25 - 2021
Type of Material: Silt and Sand, trace Clay, trace Gravel

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

Project: Southgate D-5-4

Location: N/A

File No.: M21013

Enclosure No.: 2

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Appendix D

Water Balance and Dilution Calculations

Monthly Water Balance (Thornthwaite-Mather)

Climate data from Environment Canada - DURHAM (1981 - 2010)

Potential Evapotranspiration Calculation		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average Temperature (Degree C)	T	-7.1	-6.2	-1.9	5.6	12	17	19.6	18.9	14.7	8.3	2	-3.8	
Heat index: $i = (T/5)^{1.514}$	I	0.00	0.00	0.00	1.19	3.76	6.38	7.91	7.49	5.12	2.15	0.25	0.00	**34.25**
Coefficient a $(a=0.49 + 0.0179\ I - 0.0000771\ I^2 + 0.000000675\ I^3)$	a													**1.04**
Adjusting Factor for Latitude (44^o 11' N)	d	0.81	0.82	1.02	1.13	1.27	1.29	1.30	1.20	1.04	0.95	0.80	0.76	
Adjusted Potential Evapotranspiration PET (mm) $PET = 16d(10T / I)^a$	PET	0	0	0	30	75	109	128	113	76	38	7	0	**576**

125		Based on Soil Moisture Retention of 125 mm (shallow-rooted crops/silt loam)												
All units in mm		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation (P)		103	78.5	71	73.9	93.9	85	83.7	102	115	94.2	117.4	101	**1119**
Potential Evapotranspiration (PET)		0	0	0	30	75	109	128	113	76	38	7	0	**576**
P - PET		103	79	71	44	19	-24	-44	-11	39	56	110	101	**542**
Accumulated Potential Water Loss							-24	-68	-79					
Storage (from **Soil Moisture Retention Tables**)		125	125	125	125	**125**	**124**	**72**	**65**	104	125	125	125	
Change in Soil Moisture Storage		0	0	0	0	0	-1	-52	-7	39	21	0	0	**0**
Actual Evapotranspiration (AET)		0	0	0	30	75	86	136	109	76	38	7	0	**557**
Moisture Deficit		0	0	0	0	0	23	-8	4	0	0	0	0	**19**
Moisture Surplus (P-PET - Chng in S M Storage)		103	79	71	44	19	0	0	0	0	35	110	101	**562**
Potential Infiltration (mm) (based on MOE metholodogy*; independent of temperature)		61.9	47.1	42.6	26.3	11.4	0.0	0.0	0.0	0.0	21.0	66.0	60.6	**337**
Potential Surface Water Runoff (mm) (independent of temperature)		41.2	31.4	28.4	17.5	7.6	0.0	0.0	0.0	0.0	14.0	44.0	40.4	**225**

*MOE Storm Water Management Planning and Design Manual, 2003.

topography - flat land (<0.6 m/km)	0.3
soils - medium combination clay/loam	0.2
cover - cultivated	0.1
Infiltration factor	**0.6**

number of lots	6			
total property area	2.8733	ha	7.1	acres
impermeable area	0.9000	ha	1500	sq m area covered by house/garage (250 sq m/lot)
area available for infiltration	1.9733	ha		
estimated infiltration	337.0	mm		
volume of effluent per lot	1000	L/day		
concentration of NO3 in effluent	40	mg/L		
concentration of NO3 in precip.	0.1	mg/L		
total annual effluent volume	2,190,000	litres per year		
volume of infiltration	6,650,124	litres per year		

$$\text{NO3 concentration at lot line} = \frac{(\text{NO3 conc. in effluent} \times \text{volume of effluent}) + (\text{NO3 conc. In infil.} \times \text{volume of infil.})}{\text{volume of effluent} + \text{volume of infil.}}$$

$$= \frac{40 \times 2{,}190{,}000 + 0.1 \times 6{,}650{,}124}{2{,}190{,}000 + 6{,}650{,}124}$$

$$= 9.98 \text{ mg per litre at lot line}$$

number of lots	7			
total property area	3.5411	ha	8.75	acres
impermeable area	1.2250	ha	1750	sq m area covered by house/garage (250 sq m/lot)
area available for infiltration	2.3161	ha		
estimated infiltration	337.0	mm		
volume of effluent per lot	1000	L/day		
concentration of NO3 in effluent	40	mg/L		
concentration of NO3 in precip.	0.1	mg/L		
total annual effluent volume	2,555,000	litres per year		
volume of infiltration	7,805,178	litres per year		

$$\text{NO3 concentration at lot line} = \frac{(\text{NO3 conc. in effluent} \times \text{volume of effluent}) + (\text{NO3 conc. In infil.} \times \text{volume of infil.})}{\text{volume of effluent} + \text{volume of infil.}}$$

$$= \frac{40 \times 2{,}555{,}000 + 0.1 \times 7{,}805{,}178}{2{,}555{,}000 + 7{,}805{,}178}$$

$$= 9.94 \text{ mg per litre at lot line}$$

number of lots	8			
total property area	4.2493	ha	10.5	acres
impermeable area	1.6000	ha	2000	sq m area covered by house/garage (250 sq m/lot)
area available for infiltration	2.6493	ha		
estimated infiltration	337.0	mm		
volume of effluent per lot	1000	L/day		
concentration of NO3 in effluent	40	mg/L		
concentration of NO3 in precip.	0.1	mg/L		
total annual effluent volume	2,920,000	litres per year		
volume of infiltration	8,928,113	litres per year		

$$\text{NO3 concentration at lot line} = \frac{(\text{NO3 conc. in effluent} \times \text{volume of effluent}) + (\text{NO3 conc. In infil.} \times \text{volume of infil.})}{\text{volume of effluent} + \text{volume of infil.}}$$

$$= \frac{40 \times 2{,}920{,}000 + 0.1 \times 8{,}928{,}113}{2{,}920{,}000 + 8{,}928{,}113}$$

$$= 9.93 \text{ mg per litre at lot line}$$

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Appendix E

Disposal Bed Sizing Calculations

Example Calculations - For discussion purposes only

1. Sewage Flow (Q)

a) Number of bedrooms

= 4 Bedrooms **= 2000 litres per day**

2. Minimum tank size

3600 litres minimum or 2 x sewage flow = 4000 litres or 880 imp. gallons

Fill Based Absorption Trench Installation - clayey silt soils

3. Percolation time (T)

Estimated T-time of :	sand fill		**10**	min/cm		*Estimated*

4. Minimum length of tile (L)

Minimum length of tile for maximum T-time (L=QT/200)		=	100	metres	or	328 feet
Length of tile runs		=	12.5	m	or	41 feet
Number of runs	8.0	=	8	runs	or	8 runs
Minimum tile area	Length	=	14.5	m	or	48 feet
	Width	=	13.2	m	or	43 feet
	Area	=	191	sq m	or	2060 sq. ft

5. Minimum area of bed + mantle

Estimated T-time of :	native soil		**>50**	min/cm		
Maximum sewage loading rate (R)		=	4	L/sq.m.-day		
Minimum area bed + mantle (Q/R)		=	500	sq. metres	or	5382 sq. feet