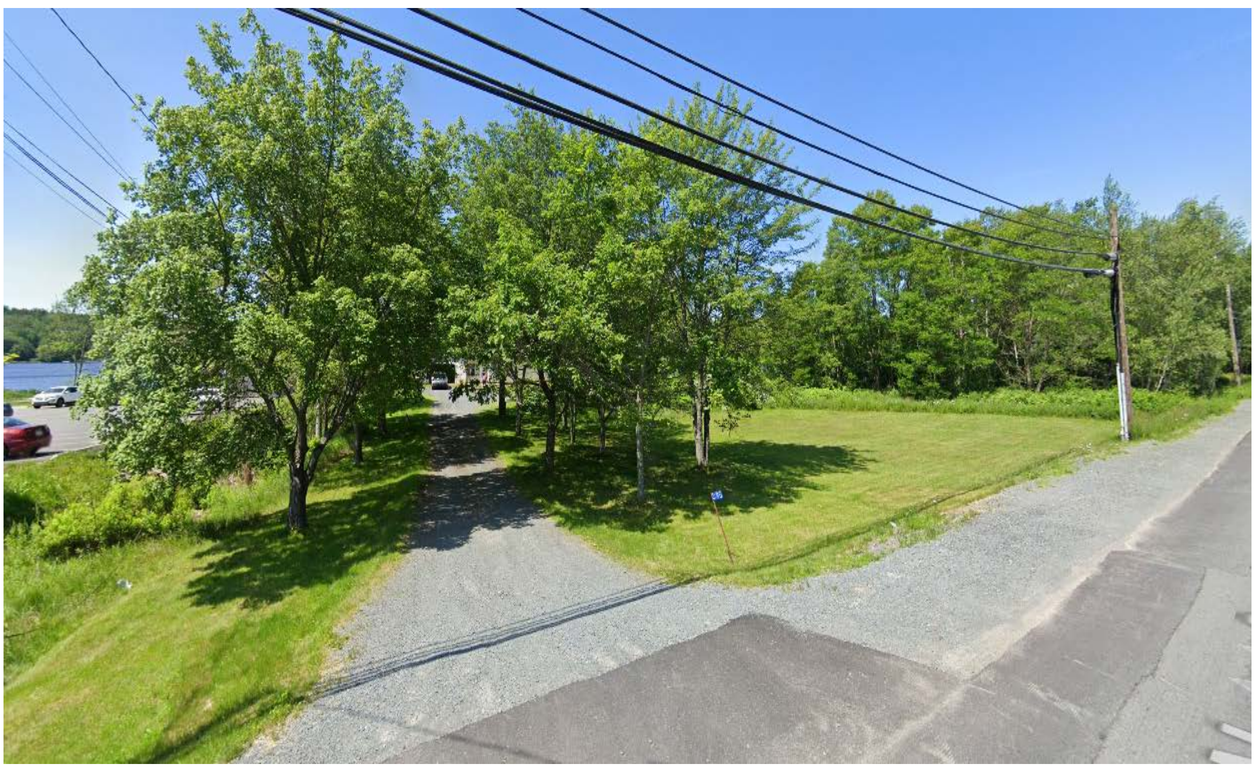
CLIENT: MICCO COMPANIES LIMITED

PHOSPHORUS NET LOADING ASSESSMENT

3195 HIGHWAY 2, FALL RIVER, NS



PHOSPHORUS NET LOADING ASSESSMENT

3195 HIGHWAY 2, FALL RIVER, NS

MICCO COMPANIES LIMITED

REPORT (VERSION 00)

PROJECT NO.: 191-12517-00
DATE: DECEMBER 22, 2020

WSP - DARTMOUTH

WSP.COM

Mr. Colin MacDonald
Micco Companies Ltd.
741 Bedford Highway
Halifax, NS, B3M 2M1

Dear Mr. MacDonald

Subject: Phosphorus Net Loading Assessment for 3195 Highway 2, Fall River, NS

WSP is pleased to submit the Phosphorus Loading assessment prepared in support of the proposed redevelopment project of the 3195 Highway 2, Fall River, NS property. We trust that this report is satisfactory.

Please contact us to address any questions or concerns you may have.

Kind regards,
Original Signed

Kevin O'Leary
Municipal Engineer

Encl.

WSP ref.: 191-12517-00

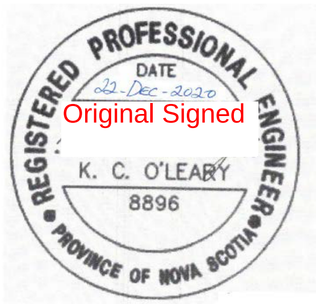
REVISION HISTORY

FIRST ISSUE

Dec. 22, 2020	Issued for Regulatory Use and Approval			
Prepared by: Kevin O'Leary, P.Eng.	Reviewed By:	Approved By:		
Municipal Engineer				
REVISION 1				

SIGNATURES

PREPARED BY



Kevin O'Leary, P.Eng.
Municipal Engineer

Date

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TABLE OF CONTENTS

1 INTRODUCTION

As part of the Development Agreement application for the 3195 Highway 2 property in Fall River, Nova Scotia (PID 00504076), a phosphorus loading assessment was completed by WSP. The project area falls within the River-Lakes Secondary Planning Strategy for Planning Districts 14 & 17 and is subject to Policy RL-22 which states:

> *"An assessment prepared by a qualified person shall be required for any proposed development pursuant to these policies to determine if the proposed development will export any greater amount of phosphorus from the subject land area during or after the construction of the proposed development than the amount of phosphorus determined to be leaving the site prior to the development taking place."*

The proposed mixed residential and commercial development consists of four attached townhouses and a 743 m^2 (8,000 ft^2) commercial building. The development will share a single common access driveway onto Highway 2. This development will manage its stormwater through a combination of surface conveyance and catch basins with discharge outlets directed towards Thomas Lake. For reference, refer to the Servicing Schematic prepared by WSP dated December 18, 2020 in the appendices.

The purpose of this assessment was to estimate the total available phosphorus discharge from the site in pre- and post development conditions and to recommend mitigation methods to achieve at a minimum, pre- and post-development phosphorus mass loading to Thomas Lake.

1.1 EXISTING CONDITIONS

The property currently supports a detached single-family home located on an established treed and grassed parcel. The parcel is approximately 0.54 ha (58,000 ft^2) and is immediately adjacent to both Highway 2 and Thomas Lake. Refer to Figure 1 for an aerial view of the site. Note in the photograph that the property south of the subject property has been developed into a commercial property in 2016 but an aerial photograph of the site of sufficient quality was not available.

The existing site has stands of relatively mature deciduous trees along the existing driveway, along the edge of Thomas Lake and along the northern boundary of the property. A portion on the property has been identified as wetland during the wetland delineation survey. Refer to Appendix B for wetland delineation map.

The remainder of the site consists of a mix of grassed areas (maintained lawn) and unmaintained grasses and bushes along the northern and southern edges of the property or tree line. The overall slope of the property lies in a northwest direction and ranges from 1-3% with the highest elevation of existing ground above the observed lake level of 3m ±.

The test pits dug during the onsite wastewater system assessment showed seepage at a depth of approximately 1 meter below existing ground. It is expected that the groundwater table on the site will be very close to the water elevation of Thomas Lake.

The existing detached single-family home is serviced by an onsite wastewater system which has not yet been located on the property. It is expected to consist of a concrete septic tank and gravity fed raised bed disposal field. There is an existing well identified on the property but whether it was in service was not determined. The well will be decommissioned as part of the property development as the property has an available service connection from Halifax Water for potable water supply.

1.2 PROPOSED DEVELOPMENT

The proposed development is outlined in the accompanying documents in support of the Development Agreement. For reference, the servicing schematic and proposed site plan is included in the appendices.

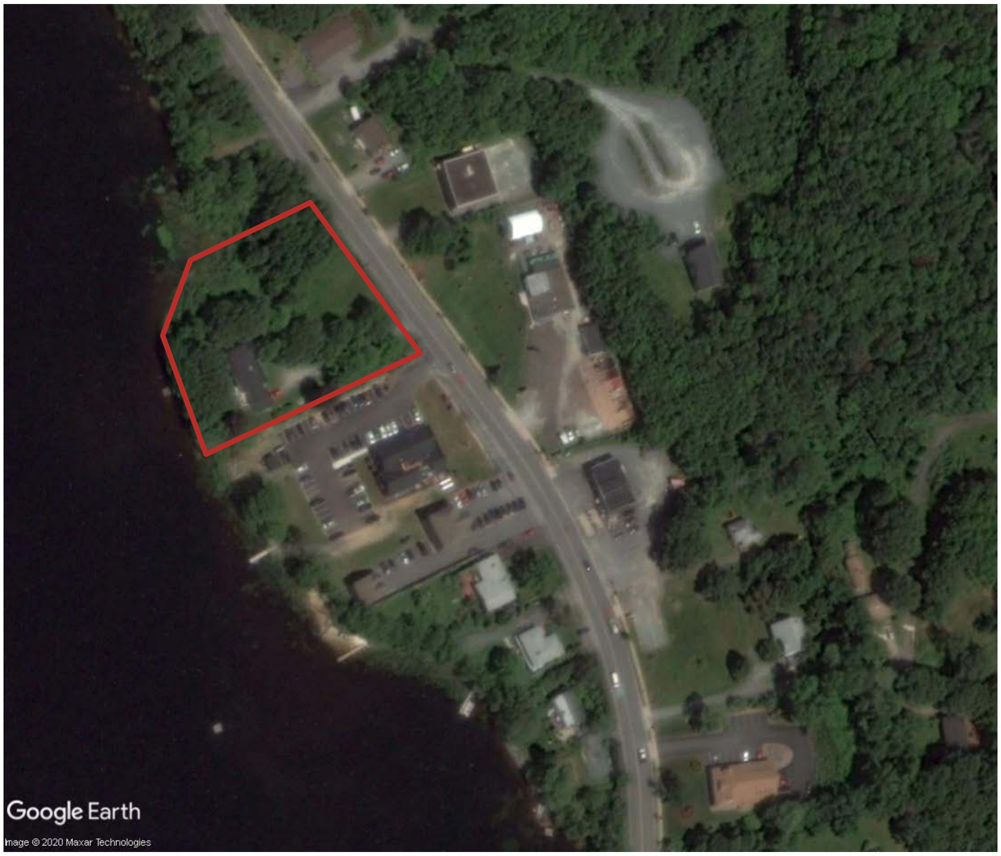


Figure 1: Aerial photograph of site (Source: Google Earth, 2020; north to top of page)

1.3 REGULATORY CRITERIA

This assessment will utilize the HRM By-Law G-200 "Respecting Grade Alteration and Stormwater Management Associated with Land Development", the "Guidelines for No Net Increase in Phosphorus for River-lakes Secondary Planning Strategy" (Hutchinson Environmental Sciences Ltd and AECOM Canada, 2014) and other references as cited to develop the project property while maintaining no net phosphorous discharge.

2 SCOPE AND METHODOLOGY

2.1 SCOPE

The purpose of the phosphorus loading assessment is to complete the following:

- Determine the pre-development total available phosphorous mass loading to Thomas Lake;
- Determine the post-development total available phosphorus mass loading to Thomas Lake; and
- Determine suitable stormwater and phosphorus controls to balance the pre- and post-development phosphorous mass loadings to Thomas Lake.

2.2 METHODOLOGY

The stormwater discharge phosphorus loads are modeled using annualized loadings. The annual phosphorus loading approach was used as mitigation measure removal efficiencies are typically assessed on annual phosphorus load reductions.

The scope of this report does not include the development of a Stormwater Management Plan or Erosion and Sediment Control Plan. This PNLA will be used to contribute to the final development of these plans. These plans will be developed by a professional engineer licensed to practice in Nova Scotia. In particular,

- Stormwater Management Plan (SWP): The SWP will address the relevant regulations including the new G-200 By-Law and will address quantity and quality of stormwater flow leaving the site. BMPs will also include measures to reduce the amount of TSS reaching the lake (e.g. bioswales).
- Erosion and Sediment Control Plan (ESCP): The ESCP will address the relevant regulations with particular emphasis of capturing run off and siltation prior to reaching the lake.

Pre- and post-development mass loadings will be determined using the following:

- Review of Existing and Historical Data: WSP reviewed aerial photographs and historic Environment Canada climate data. WSP staff also visited the site during an investigation for an onsite wastewater system
- Hydrology: The project site is small (0.54 ha) and will be considered a single watershed as stormwater from the adjacent property and road will be carried to Thomas Lake via the existing or existing swales or piping.
- Water Quality Modelling: Total phosphorus loadings will be modelled using cited references including Stormwater Management Standards for Development Activities (HRM, 2020) and Guidelines for No Net Increase in Phosphorus for River-Lakes Secondary Planning Strategy (Hutchinson Environmental Sciences Ltd and AECOM, 2014). The models will reflect existing and proposed conditions, recommended estimated total phosphorous runoff coefficients and stormwater Best Management Practices (BMPs).

3 MODEL DEVELOPMENT

In the existing and proposed conditions, the model will consider the annualized phosphorus loadings using existing the type and area of the various land cover and buildings. The phosphorus loadings from the existing and proposed onsite wastewater treatment system will also be included.

3.1 STORMWATER CATCHMENT DELINEATION

The stormwater catchment area was delineated using aerial photography, site visits and preliminary topographic data collected during the onsite wastewater assessment. Along the southern property line adjacent to the Turtleback Tap & Grill and Fall River Dental commercial building, stormwater is collected in a vegetated swale. Based upon observed site grading, the majority of stormwater collected on this adjacent property is controlled on their property. Along the eastern property line adjacent to Highway 2 and west of the crown of the road flows towards the proposed property development. Stormwater east of the crown on the road is captured by a curb and gutter system and is released further downstream away from the subject property. Stormwater that flows off the road is captured by a slight swale at the front of the subject property, flows north along the shoulder of the road until it intercepts the vegetated area and flows towards Thomas Lake into the identified wetland areas.

The phosphorus assessment will consider all areas within the catchment area but will not include any phosphorus loadings that may arrive from offsite stormwater flow. The total area of the property is 0.54 ha (58,00 ft^2) ±. Once a complete topographic and boundary survey of the property has been completed, a more accurate perimeter of the property along Thomas Lake will be measured.

3.2 LAND USE

Pre- and post-development land use and their associated areas are outlined in the table below.

Table 2: Pre-Development Land Use

	Area (m^2) (to nearest 25 m^2)	Phosphorus loading values (mg/L)[3]	Phosphorus export coefficient (g/m^2-yr)
Wetland	725	0.2	0.008[1]
Treed	1,200	0.2	0.035[2]
Low Density Residential	3,475	0.2	0.035[2]

1 Forest Watershed with >15% cleared/wetland (Brylinksy (2004))
2 Residential Lot (Brylinksy (2004))
3 HRM Guidelines (2006) and Toronto Area Watershed Assessment

Table 3: Post-Development Land Use (No Stormwater BMPs)

	Area (m^2) (to nearest 25 m^2)	Phosphorus loading values (mg/L)[5]	Phosphorus export coefficient (g/m^2-yr)
Wetland	375	0.2	0.008[1]
Treed	850	0.2	0.035[2]
Medium Density Residential/Commercial	2,500	0.2	0.035
Asphalt Parking	1,125	0.62	0.350[3]
Commercial Building	375	0.04	0.035[4]
Multi-Unit Attached	175	0.04	0.035[4]

1 Forest Watershed with >15% cleared/wetland
2 Residential Lot (Brylinksy (2004))
3 Public Highways (Brylinksy (2004))
4 Considered part of the medium density residential/commercial
5 HRM Guidelines (2006) and Toronto Area Watershed Assessment

3.3 ON-SITE WASTEWATER SYSTEM

Phosphorus concentrations in primary tank effluent varies widely from region to region but typically falls within the range of 10 – 35 mg/L of total phosphorus. Approximately two thirds to three fourths of this phosphorus is available as freely available orthophosphate. The remainder is bound with organic molecules (DNA) and other biological compounds. For the purposes of this assessment, we assumed an available phosphorus concentration of 20 mg/L in primary effluent.

It is understood that new septic disposal beds are greater than 95% effective at removing available phosphorous via reactions with soil minerals (particularly aluminum and iron containing minerals). Long term phosphate attenuation is not well developed but similar to other soil mineral reactions with various cations and anions, it is expected that this ability would decrease as the available sites for reaction were either hidden via mineral deposition or otherwise unavailable for further reaction. One assessment showed that over the long term (14-22 years) disposal beds lost approximately 90% of their ability to capture and remove phosphorus (Eveborn *et.al*, 2012).

Phosphorus treatment with a typical onsite treatments system is not expected to substantially remove phosphorus. Removal of phosphorus using biological means requires specialized unit processes capable of taking advantage of a subset of bacterial know as phosphorus accumulating organisms. These types of treatment technologies require knowledgeable operators and are not usually included in small onsite systems.

Therefore, for this model given the proximity of the lake we are assuming that any phosphorus reaching the disposal bed will be discharged into Thomas Lake. This does not account for any attenuation due to reactions or travel time but does yield a conservative estimate for phosphorus loading. Outside of the overuse of fertilizers, onsite wastewater is one of the largest contributors of phosphorus to the receiving body.

3.3.1 Existing System

The existing onsite septic system servicing the single-family home is assumed to consist of a precast concrete tank with effluent filter. Primary effluent is probably discharged via gravity flow to a mound type system consisting of filter sand above native material or approved fill.

Onsite wastewater systems are designed to accommodate the expected peak flows from their service area or unit. For a single-family home, the design flow for up to a three-bedroom home is 1,000 litres per day. Average daily flows are typically 50% of the prescribed design flows so for the purposes of modelling, 500 litres per day of effluent discharge to the bed was used.

3.3.2 Proposed System

The proposed onsite septic system will consist of primary tankage, an advanced treatment unit and a disposal bed. The prescribed flows for the townhouse units is 3,250 L/d. The 744 m^2 commercial space has no specified tenants therefore the prescribed flow is given by an upper limit of 61 office workers at 50 litres per day per office worker. For the purposes of modeling, 6,300 litres per day of effluent discharge to the bed was used.

3.4 AREA LOADING METHOD

For the areal loading method, the annual phosphorous export loading is estimated using the following:

$$\dot{m}_{P,Land\ Use} = \sum_{i=1}^{n} P_{Land\ Use\ i}\, A_{Land\ Use\ i}$$

where:

$\dot{m}_{P,Land\ Use}$: Total mass Loading of phosphorus leaving the site based on all of the land use types (kg/yr P)

$P_{Land\ Use\ i}$:Phosphorus unit loading rate for a given land use *i* (g/(m^2*yr))

$A_{Land\ Use\ i}$: Area with a given land use *i* (m^2)

This method treats the onsite wastewater system as a point source and the estimation of the loading is given by the following:

$$\dot{m}_{P,Septic} = C_{p,septic} * Q_{septic}$$

where:

$$\dot{m}_{P,Septic}$$

Mass Loading of phosphorus leaving the primary tank prior to treatment (kg/yr P)

$C_{P,\ septic}$: concentration of phosphorus in primary effluent (mg/L P)

Q_{septic}: average flow from the septic system (L/d)

If an additional physicochemical treatment process is added to the treatment train, the expected phosphorus removal fraction is applied to the effluent mass loading calculated previously.

4 RESULTS AND DISCUSSION

4.1 PHOSPHORUS MASS LOADING FROM LAND USE ACTIVITIES AND ON-SITE SEPTIC SYSTEM

The area mass loadings were run for both pre- and post-development scenarios without the addition of any stormwater BMPs. The results for both runs are outlined below.

The proposed end use of the commercial building is for undefined commercial and office space. The proposed onsite system can receive 3,050 litres per day of typical domestic wastewater. Typical strength of raw domestic wastewater is 200 mg/l total suspended solids, 175 mg/L biochemical oxygen demand, 425 chemical oxygen demand, 20 mg/L of ammonia nitrogen and 20 mg/L P. Any tenants that would cause the strength or treatability of the wastewater to change should be subject to review prior to acceptance. This includes tenants such as brewery pubs, veterinary clinics, cleaning supply and service companies. In general, tenants that create overstrength wastewater or release discharges that affect the treatment system's process biology should be restricted from becoming a tenant.

Table 4: Pre-Development Uncontrolled Phosphorus Loadings

Land Use	**Area**	**Area (ha)**	**P Export Coefficient**	**Phosphorus Loading**	
	m^2	**ha**	**$g/(m^2*yr)$**	**kg/yr**	**g/yr**
Wetland	725	0.0725	0.008	0.006	6
Treed	1200	0.12	0.035	0.042	42
Low Density Residential	3475	0.3475	0.035	0.122	122
Total	5400	0.54	---	**0.169**	169
	Flow	**P Conc.**	**Phosphorus Loading**		
	l/d	**mg/L**	**mg/d**	**kg/yr**	
Onsite Septic System	500	20	10000	3.65	
Total Loading				**3.82**	

Table 5: Post Development Uncontrolled Phosphorus Loadings

Land Use	Area	Area (ha)	P Export Coefficient	Phosphorus Loading	
	m^2	**ha**	**$g/(m^2*yr)$**	**kg/yr**	**g/yr**
Wetland	375	0.0375	0.008	0.003	3
Treed	850	0.085	0.035	0.030	30
Medium Density Residential/Commercial	2500	0.25	0.035	0.088	88
Asphalt Parking	1125	0.1125	0.62	0.698	698
Commerical Building	375	0.0375	0.04	0.015	15
Multi-Unit	175	0.0175	0.04	0.007	7
Total	5400	0.54	---	**0.840**	840
	Flow	**P Conc.**	**Phosphorus Loading**		
	l/d	**mg/L**	**mg/d**	**kg/yr**	
Onsite Septic System	6300	20	126000	46.02	
Total Loading				**46.86**	

Based on the model results shown above, it was determined that phosphorus reductions are warranted and that the onsite septic system is the largest contributor to phosphorus loadings. Even with the use of efficient phosphorus capture stormwater BMPS, the phosphorus loading from the new onsite plant is more than six times the existing phosphorus loadings from the existing on-site system.

Given that the phosphorus loadings from the onsite wastewater system is more than an order of magnitude greater than land use related loadings, it is recommended that phosphorus removal be included within the onsite treatment train. Therefore, it is recommended that alum or ferric salts be used precipitate available phosphorus. These types of chemical precipitation processes are capable of achieving final phosphorus concentrations of 0.5 mg/L and/or 95% removal in higher strength wastewater.

Alum reacts with phosphorous to create an aluminum phosphate precipitate. By mass, 9.6 mg of alum is required for each mg of phosphorus. Typical dosing is 1.5 to 2.0 times this ratio to accommodate reactions with other competing reactions with other organics (humics) or metals. Alum dosing would be accomplished via a small chemical feed pump and a stock solution of alum. We would recommend that the dosing system be installed in the commercial building's mechanical room. In terms of the impact to operations of the onsite system, the alum sludge would build up along with the biosolids in the primary tank. Commercial septic tanks are normally pumped every one or two years as part of normal maintenance, so the alum sludge would be removed at the same time.

5 CONCLUSIONS

Based on the modelling results outlined in this assessment it is recommended that the onsite treatment plant utilize phosphorous removal technologies to achieve the site's overall goal of no net phosphorus leaving the site. This will be accomplished through the uses of tertiary treatment technologies for phosphorus removal within the overall onsite treatment system.

Any proposed tenants for the building should be assessed for their impact on the onsite treatment system. Any tenants that propose to discharge overstrength, toxic or excess wastewater should be reviewed

Stormwater Management and Erosion and Sediment Control Plans shall be developed and submitted for review by the relevant agencies.

BIBLIOGRAPHY

Eveborn, David, Kong, Deguo and Gustafsson, Jon Petter (2012). Wastewater treatment by soil infiltration: Long-term phosphorus removal. *Journal of Contaminant Hydrogeology*. 140-141, 24-33.

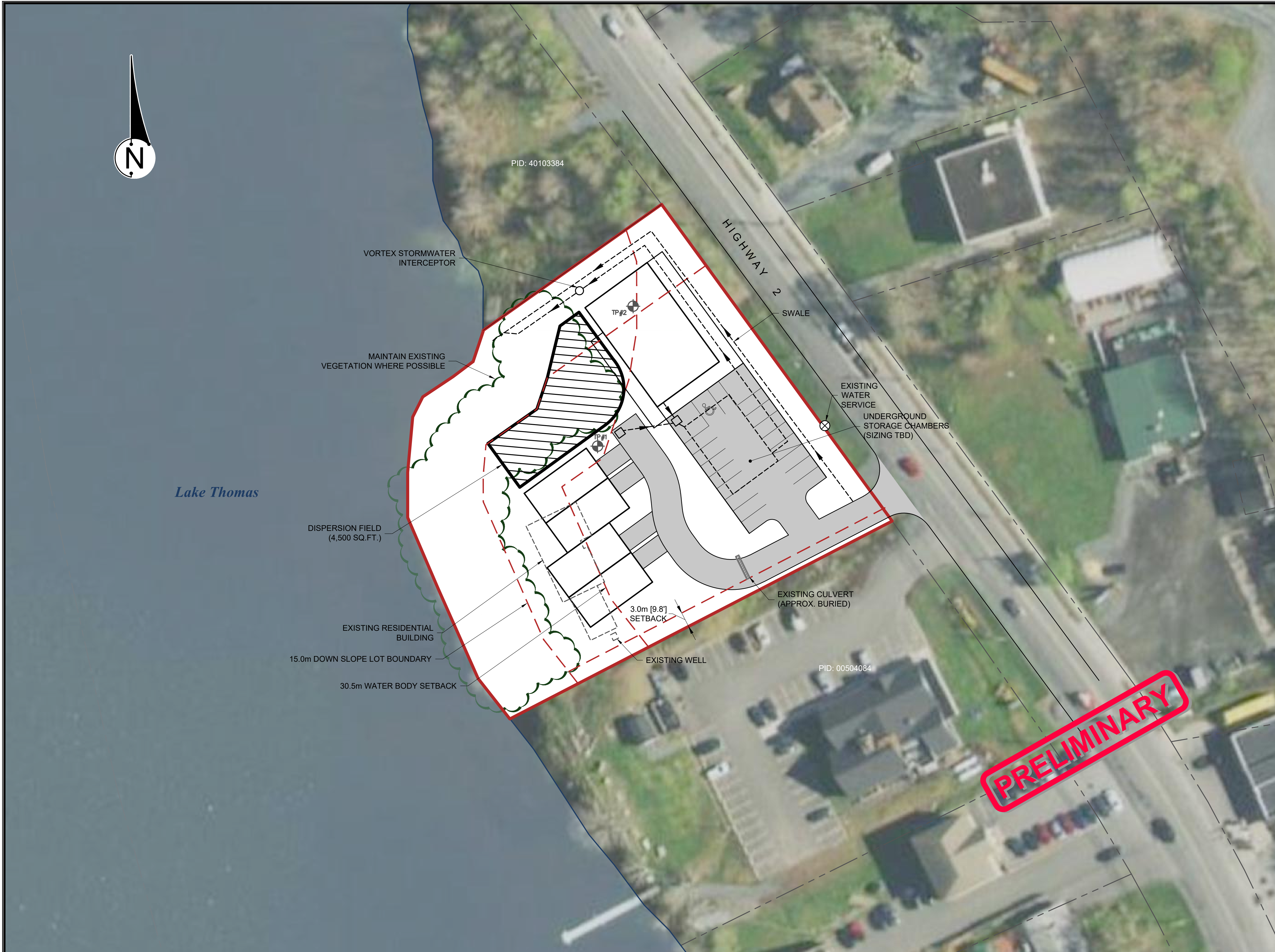
Brylinsky, M. (2004). User's Manual for Prediction of Phosphorous Concentration In Nova Scotia Lakes: A Tool for Decision Making. The Nova Scotia Water Quality Objectives and Model Development Steering Committee. Nova Scotia Department of Environment and Labour.

APPENDIX

A

SERVICING SCHEMATIC &

WETLAND DELINEATION



LEGEND

- Site Boundary
- Adjacent Property Boundary
- Waste Water Related Setbacks

SITE SUMMARY:

- PID: 00504076
- Land Area - 5,572 m²
- Existing Zone - VMS (Village Main Street Zone)

NOTES:

- Property lines approximate only. Site subject to survey.
- Community on central drinking water. Any use of wells at adjacent properties to be confirmed during design.
- Anticipated flow: 6,200 LPD
- Soil type to be confirmed; assuming sandy silt.
- Vertical loading: 15 LPD / sq.m.
- Area: 418 sq.m. (4,500 sq.f.)
- Treatment to include secondary for BOD & TSS reduction and UV for fecal reduction to <200 CFU per 100mL.
- 3.0m boundary on road frontage and southern property boundary are not shown.

SOURCES:

- Property lines and topographic features from Provincial mapping

Designer: K. O'LEARY
Planner: C. LUTZ/JHARPER

VERSION
100

ONSITE WASTE WATER CONCEPT PLAN
HWY. 2, FALL RIVER, NOVA SCOTIA

MICCO COMPANIES LIMITED

DECEMBER 18, 2020 171-01152-100_SEPTIC_2020-12-18

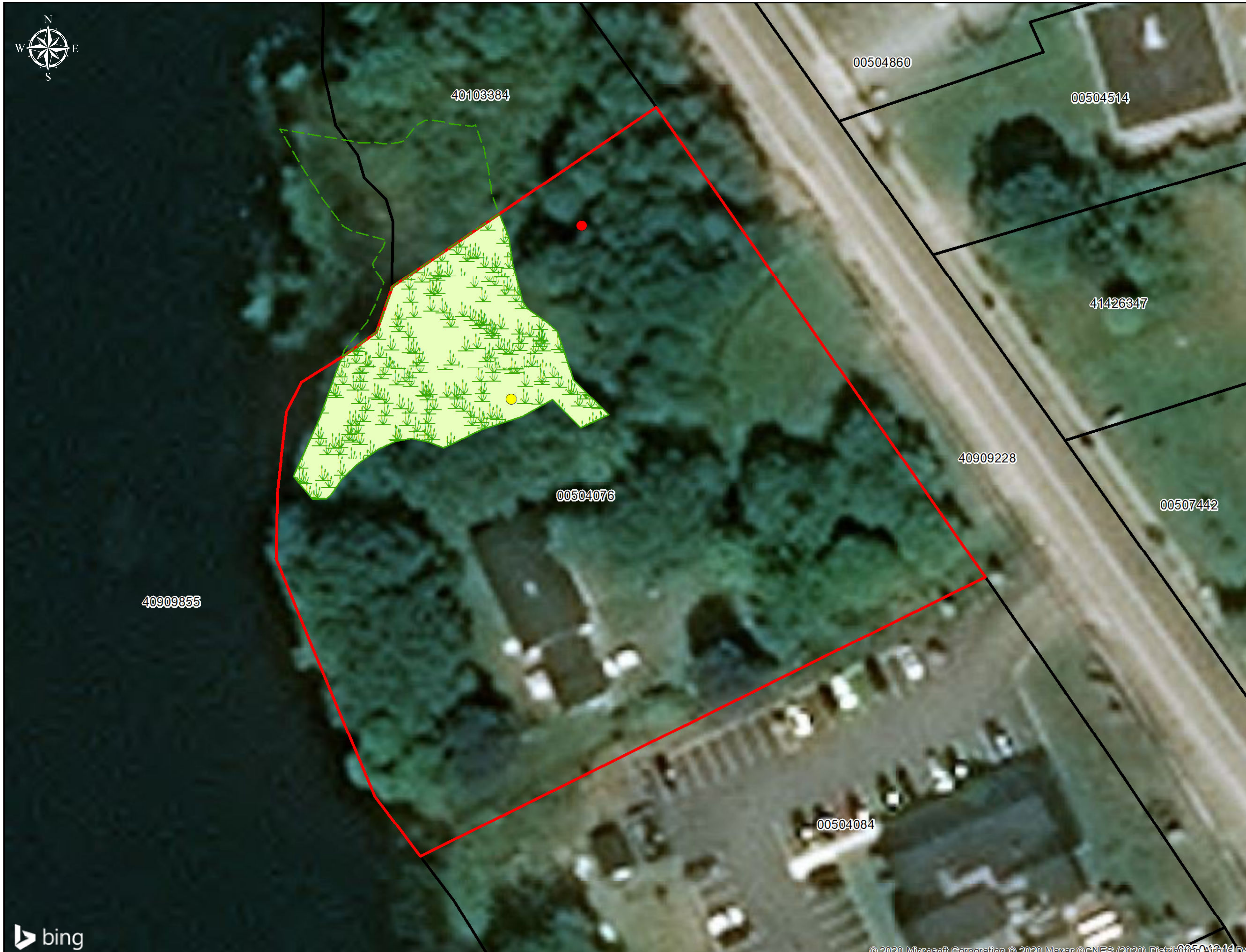
SCALE

12 8 4 0 20 m
1 : 750

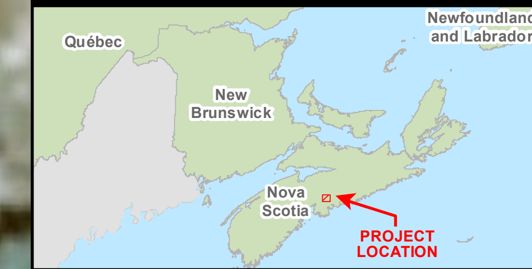
WSP Canada Inc.
1 Spectacle Lake Drive
Dartmouth, Nova Scotia, Canada B3B 1X7
T 902-835-9955 F 902-835-1645 www.wsp.com

Sheet:Standard 11x17 L

FILE: K:\DARTMOUTH\2019\191-12517_MICCO_COMPANIES_LTD_FALL_RIVER_DEV\15-DWG\15.1-CONCEPT_PLANS\DEC2020 SEPTIC_SERVICING PLAN\171-01152-100_SEPTIC_2020-12-18.DWG



KEY MAP:



LEGEND:

SAMPLE LOCATION

- Upland Sample
- Wetland Sample
- Wetland Delineation (Outside PID 00504076) ~387 m^2
- Wetland Delineation (Inside PID 00504076) ~712 m^2
- Subject Area (PID 00504076)
- Property Boundary (Nova Scotia, 2017)

PROJECT:

PROJECT: **WETLAND DELINEATION FOR PID 00504076**

PROJECT NO.: **191-12517-01**

CLIENT: **MICCO**

FIGURE:

TITLE: **WETLAND DELINEATION**

FIGURE NO.: 1	REVISION NO.: 0
SCALE: 1:500 (0 5 10 20 Metres)	
DATUM: NAD 83 CSRS	PROJECTION: UTM ZONE 20 NORTH
DRAWN BY: T. MOREHOUSE	CHECKED BY: T. MacAULAY
CREATED DATE: (YYYY-MM-DD) 2020-07-16	REVISION DATE: (YYYY-MM-DD) 2020/07/16

wsp
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PATH: S:\GIS\2_PROJECTS\2019\191_12517_MICCO_WLDelineation_FallRiver_NS\8_MXD\20200716_191_12517_01_WetlandDelineation.mxd SOURCE: NSDNR Wetland Database, 2015; BING Background Imagery, 2016