TRCA Wetland Water Balance Risk Evaluation – 74 Edwards Drive, Keene, Ontario

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Prepared for:
Yvette Johnston

Cambium Reference: 15831-002

CAMBIUM INC.

866.217.7900

cambium-inc.com

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1.0 Introduction

Yvette Johnston (Client) retained Cambium Inc. (Cambium) to conduct a Wetland Water Balance Risk Evaluation at 74 Edwards Drive, Keene, Ontario (Site; Figure 1). It is understood that the proposed subdivision development would subdivide the western portion of Site into 16 residential lots. The development will include a roadway, wildlife corridor, parkland, and storm water management (SWM) features. Stormwater will be directed to a series of storage tanks located beneath the access roadway, with runoff being controlled with an outlet at the downstream end of the facility, discharging to the wetland to the east (Jewell Engineering, 2024). The proposed development will be provided with water servicing from a municipal supply. However, wastewater will be treated onsite with private treatment systems. The SWM facility is proposed to be lined (preventing infiltration) and directed north, then east into the on-site wetland. Conceptual Site Plans are provided in Appendix A.

Otonabee Conservation confirmed that a Wetland Water Balance Risk Evaluation (hereafter called the Risk Evaluation), referencing the Toronto and Region Conservation Authority (TRCA) guidelines (TRCA, 2017), is required to support the proposed development. Since the SWM facility will discharge to the wetland, a TRCA Wetland Water Balance Risk Evaluation was required to determine the level of effort and scope of follow up wetland impact assessments.

This report addresses the requirements of the Risk Evaluation and provides summarizing conclusions and recommendations pertaining to the proposed development.

1.1 Site Description

The Site is located on the parcel address 74 Edwards Drive on Otonabee Concession 7, Lot 14 in the Township of Otonabee South Monaghan. The Property Roll Number applicable to the Site is 150601000324300000000. The property is classified as a future Development 8 (FD-8) Zone.

The Site is approximately 14.1 ha in size and is irregularly shaped. The 4.94 ha area on the east of the Site is a Regulated Area by Otonabee Conservation and will not be developed.

The Site is situated in an area that is undeveloped and is heavily vegetated with a mix of trees, shrubs, and grasses. Agricultural land use borders the Site to the south and west and northwest. Residential and rural residential land use borders the Site to the east and northeast. There is a public school located along the southeast border of the Site. Indian River is located approximately 580 m east of the Site.

The regional location of the Site is outlined on Figure 1 and the property boundaries are outlined on Figure 2 and Figure 3.

2.0 Methodology

2.1 Review of Previous Investigations

2.1.1 Cambium Investigations

Cambium previously conducted a Geotechnical Investigation, Hydrogeological Assessment, and an Environmental Impact Study (EIS) (Cambium, 2023; 2024a; 2024b). The EIS includes both a background review and a comprehensive field program documenting flora and fauna and delineating the wetland located on Site.

As part of the hydrogeological and geotechnical work programs, 16 test pits and 10 boreholes were completed on October 11, 2022, and October 19 to 20, 2023 respectively. Three boreholes were completed as monitoring wells and designated as BH101-23, BH107-23, and BH109-24. The location of the boreholes, test pits, and monitoring wells are included Figure 2. Detailed subsurface descriptions and the borehole logs are in the Geotechnical Investigation report (Cambium, 2023). The reports were reviewed during this investigation and referenced for historical subsurface and hydrogeological Site conditions.

2.2 Ecological Field Investigations

Information gathered through the background information review was used to guide the development of the fieldwork program. The purpose of the Site visits was to verify information acquired through existing documentation and to gather additional site-specific information. The following sections detail the methodologies that were applied.

2.2.1 Ecological Land Classification

The Ecological Land Classification (ELC) System for Southern Ontario was used to classify vegetation communities on the Site. Definitions of vegetation types are derived from the ELC for Southern Ontario First Approximation Field Guide and the revised 2008 tables. ELC units were initially delineated and classified by orthoimagery interpretation. Field investigations served to confirm the type and extent of communities through vegetation inventory and soil assessment with a hand auger. Where vegetation communities extend off the Site, classification is done through observation from property boundaries and publicly accessible lands.

2.2.2 Wetland Boundary Delineation

The subject wetland was delineated following provincially approved methods outlined in the Ontario Wetland Evaluation System: Southern Manual 4th Ed. (Ministry of Natural Resources, 2022). Wetland boundaries were initially delineated and classified by orthoimagery interpretation, then confirmed through field investigations.

The wetland boundary was delineated in the field over two visits, on August 16, 2022, and September 23, 2024, by Ontario Wetland Evaluation System (OWES) certified Cambium staff. Wetland boundaries were determined using the 50% wetland vegetation rule. Where vegetation-based delineation was inconclusive, soil assessment with a hand auger was used to confirm wetland boundaries. Wetland boundaries on the Site were staked and marked with a hand-held GPS unit.

2.2.3 Aquatic Habitat Assessment

Aquatic habitat surveys were completed to identify and map all aquatic features on Site, including waterbodies, watercourses (permanent and intermittent), seeps, springs, and overland drainage paths. Orthoimagery and topographical mapping were reviewed to identify hydrologically connected aquatic features on adjacent lands that were inaccessible during the field assessments. On-site features were characterized based on in-stream and riparian cover, channel structure/morphology, substrates, flow, and hydrologic characteristics, as well as general documentation of channel instability, erosion/sedimentation, groundwater, and flow permanency indicators. If present, crossing features including bridges, culverts, and bed-level crossings were noted and georeferenced in the field. Standard assessment methods and technical criteria referenced in the Ontario Stream Assessment Protocol (Ministry of Natural Resources and Forestry, 2017) were applied to wadeable streams. All identified aquatic features were assessed to determine their potential function as fish habitat, with consideration for sensitive, limiting, or critical habitat, such as spawning locations, overwintering habitat, and migratory corridors. Fish observations, habitat connectivity, and barriers to fish movement were documented, when present, to provide regional context to their function within the general aquatic network and sub-watershed.

2.2.4 Fish Community Sampling

Sampling methodologies for determining the presence, abundance, and distribution of fish within aquatic habitats vary depending on study objectives, habitat conditions, and target species. For all aquatic habitat sampling, Cambium employs sampling techniques in alignment with industry standards, based on guidance provided by applicable government agencies and ministries, and in accordance with manufacturers instructions for field equipment usage. All aquatic sampling was carried out by qualified Cambium staff, under the supervision of a qualified aquatic ecologist.

Fish community sampling was carried out a single representative site within aquatic features downstream of the Site. Community sampling on Site proved to be non-feasible due to dense vegetation limiting access, as well as shallow waters limiting the use of sampling equipment. In lieu of sampling equipment, Cambium ecologists walked the aquatic habitats to observe any frightened fish. The off-Site sampling occurred within a downstream portion of the same watercourse that flows through the Site. This location was the closest to the Site that permitted safe and legal access, as well as sufficient water depths to utilize sampling equipment.

2.2.5 Breeding Bird Surveys

Two breeding bird surveys were carried out during the peak breeding season between May 25 and June 1, 2023, the minimum of seven days apart. Point counts were completed using the OBBA Guide for Participants (Ontario Breeding Bird Atlas, 2001). Point count stations were established in various habitat types and were combined with incidental observations to determine the presence, variety, abundance, and breeding evidence of species. As outlined in the OBBA protocol, point counts are to be done between dawn and five hours after dawn, when wind speed is low (<19 km/h) and in the absence of rain or thick fog. Surveys conducted outside of this five-hour window remain valid, provided that the protocol adjustment is documented and justifiable. All species observations (visual and auditory) were recorded at predetermined point count stations during a five-minute period. Observations were also documented between point count stations and were tabulated with the nearest station. Each species observed was classified and assigned a code based on the highest level of breeding evidence, as defined by the protocol: Confirmed, Probable, Possible or Observed.

The NHIC database and SARO list were reviewed to determine the current provincial status for each bird species.

2.2.6 Winter Raptor and Stick Nest Survey

Visual surveys for winter use of the property by raptors were completed in accordance with a modified version of the Hawk Migration Association of North America (HMANA) protocol. A single survey was conducted during leaf-off conditions. The HMANA protocol was developed for long-term monitoring, and is not fully compatible with a site specific, short-term evaluation of use of a particular area. As such, the data collected by Cambium should be viewed as a snapshot in time, and not a reflection of overall or long-term migration patterns of raptors in the area. Sightings of raptors and habitat were noted, if applicable.

2.2.7 Amphibian Breeding Surveys

The presence of frog and toad breeding habitat was determined using auditory surveys following the Marsh Monitoring Program Participant's Handbook for Surveying Amphibians (Bird Studies Canada, 2008). Surveys were conducted during the appropriate survey periods and satisfying specific minimum temperature values.

2.2.8 Wildlife Tree Surveys

Snag and cavity trees provide habitat for wildlife including a range of bird and mammal species. A snag or cavity tree is defined as a standing live or dead tree ≥10 cm diameter at breast height (DBH), with cracks, crevices, hollows, cavities and/or loose or naturally exfoliating bark appropriate for bat roosting. According to Ministry of Natural Resources and Forestry (MNRF) guidance, high quality or Maternity Roost Colony SWH is defined as woodlands with greater than 10 roost trees per hectare.

To determine if suitable habitat for bats existed on/or adjacent to the Site, Cambium staff conducted a bat maternity roost survey using the methods detailed in the *Bat and Bat Habitats: Guidelines for Wind Power Projects* (Ministry of Natural Resources, 2011) and the 2022 Update (Ministy of Natural Resources and Forestry, 2022).

2.2.9 Bat Acoustic Monitoring

Bat acoustic monitoring surveys were completed to determine, with reasonable certainty, the bat species present in the immediate area of the Site. Bat species were identified using analysis of sonographic characteristics from recordings of ultrasonic calls emitted by bats for echolocation. Survey methods were developed based on the MNRF survey guidelines outlined in Bat and Bat Habitats: Guidelines for Wind Power Projects (2011) and current guidance provided by MNRF for surveying SAR bats in Ontario (Ministy of Natural Resources and Forestry, 2022). Surveys were conducted using broadband bat detectors (Wildlife Acoustics Song Meters) appropriately placed in target habitats. Passive acoustic recorders were programmed to begin recording 30 minutes before sunset through 30 minutes after sunrise. Surveys were carried out in the month of June for 10 consectutive nights. Data was processed using equipment specific software to identify bats to species, to the extent possible. All calls, including unidentifiable calls, are reported in the survey data. The NHIC database and SARO list were reviewed to determine the current provincial status for all bat species identified.

2.2.10 Habitat-Based Wildlife Surveys

Given the scale of the proposed development, a habitat-based approach was used to assess potential impacts to wildlife, consistent with standard practice. General habitat information gathered through the field investigations was used to assess the connectivity of the Site with the surrounding landscape and evaluate the ecological significance of the local area. Cambium staff actively searched for features that may provide specialized habitat for wildlife. These searches included inspecting tree cavities, overturning logs, rocks and debris, and scanning for scat, browse, sheds, fur, etc. Any evidence of breeding, forage, shelter, or nesting was noted. Species habitat and nesting observations were documented and photographed.

2.3 TRCA Wetland Water Balance Risk Evaluation

The methodology outlined in the Wetland Water Balance Risk Evaluation by the Toronto and Region Conservation Authority (2017) was followed in this Risk Evaluation. The purpose of the Risk Evaluation is to assign a level of risk to the proposed works based on the sensitivity of the wetland and the potential magnitude of hydrologic change in the absence of remedial action. The level of risk was used to determine whether a water balance, mitigation measures and/or modelling is required.

The Risk Evaluation was completed in 4 steps:

- **Step 1:** Determination of the retained wetland
- **Step 2:** Determine magnitude of hydrological change
- **Step 3:** Determine the sensitivity of the wetland, flora and fauna to hydrologic change
- **Step 4:** Assign level of risk to the proposed development

The following data criteria were determined based on the guidance from Table 1 of the TRCA Risk Evaluation report (TRCA, 2017).

- **Wetland Feature Limits:** The wetland feature limits were delineated by provincially certified Cambium staff according to OWES methods detailed in Section 2.2.2. The size and shape of the existing wetland were referenced from catchment information provided by Jewell Engineering and are shown in Figure 4.
- **Extent and Size of Pre-Development Catchment (C):** Surface water catchment of the wetland was determined from catchment information provided by Jewell Engineering. All the pre-development catchments are included on Figure 4. Sub-catchments in the wetland catchment include 100,102, 103 and 104. These sub-catchments were summed to determine C.
- **Total Development Area of Catchment (C_{dev}):** The total development area of the catchment not including the wetland and buffer. C_{dev} is determined by adding the areas of the pre-development catchments within the wetland catchment that would have the potential

to be developed. The total development area within the pre-development wetland's catchment is in the sub-catchments 100, 102, 103 and 104 (which is C). The area of the wetland and buffer of 4.94 ha (see Figure 5) was subtracted from C to determine C_{dev}.

- **Area of the Wetland Catchment Owned by the Proponent:** The proposed development area of the wetland catchment that is owned by the proponent which contributes to the post-development impervious cover is the sub-catchments A1, A2, A4, and A5 (see Figure 5)
- **Percent of Impervious Cover Planned Within the Proponent's Holdings (IC):** The anticipated proportion of impervious cover within the area of wetland catchment was determined using land cover information provided from Jewell Engineering and the MNRF Ontario Watershed Information Tool (OWIT). IC was calculated as a percentage between 0 and 100. The wetland catchment (C) is already partially developed, as such IC is considered to be the percent increase in impervious surface which would result from the proposed development.

  To calculate IC, the area of impervious surfaces found within the wetland catchment pre-development are compared against the total impervious surfaces found within the wetland catchment post-development. IC is the percent increase in total impervious surfaces that will be developed within the wetland catchment upon development of the Site. Impervious surface area associated with the proposed development was provided by Jewell Engineering.
- **Proposed Extent and Size of Post-Development Catchment:** The anticipated post-development size of the wetland's catchment resulting from SWM changes was determined from catchment information provided by Jewell Engineering. All the post-development catchments are included on Figure 5. The sub-catchments include A1, A2, A4, A5, and A6. These catchments areas were summed to determine the post-development catchment extent.
- **Anticipated Magnitude and Duration of Water Taking:** The approximate magnitude and duration of groundwater taking was assumed to be short term (~6 months at a maximum), during construction dewatering for the footprint of the proposed houses. At this stage of

development, long term dewatering is not anticipated. Neither a detailed Site Plan nor a detailed dewatering assessment have been developed for the Site. A preliminary dewatering estimate has been prepared using number of assumptions and the best available data. The dewatering flows discussed in Section 3.2.3 are preliminary and should be revised once detailed designs are available for review.

- **Location and Extent of Any Locally Significant Recharge Areas:** Locally significant recharge areas were determined from background data review of Ministry of the Environment Conservation and Parks (MECP) Source Protection Information Atlas (SPIA), as well as available soils information from Cambium's previous geotechnical investigation
- **Vegetation Community Type:** Classification according to the ELC System as detailed in Section 2.2.1.
- **Fauna Species Present:** A list of fauna species found in the wetland was created based on the results of the surveys detailed in Sections 2.2.4 through 2.2.10 and cross referenced with the sensitivity ranks provided in Appendix 3 of the TRCA guidance document.
- **Flora Present:** A list of flora species found in the wetland was created based on the results of the survey detailed in Section 2.2.1 and cross referenced with the sensitivity ranks provided in Appendix 3 of the TRCA guidance document.
- **Habitat Features:** The presence of features which provide habitat for wildlife and/or fish, including amphibian breeding, bird breeding, reptile or amphibian overwintering habitat were considered, with reference to Significant Wildlife Habitat.
- **Wetland Hydrological Type:** The wetland was hydrologically classified following OWES conventions (Ministry of Natural Resources, 2022).

3.0 Results

3.1 Step 1 – Potentially Affected Wetlands

There is one subject wetland on Site that may be impacted by the proposed development. The wetland and wetland buffer encompasses an area 4.94 ha. The wetland on Site consisted of two different wetland community types - White Cedar Mineral Coniferous Swamp and Red-osier Mineral Thicket Swamp and was delineated in 2022, and refined in the 2024 EIS for the Site (Cambium, 2024b).

Using catchment information provided by Jewell Engineering, the pre-development catchment area of the wetland (C) was calculated to be 50.75 ha (the sum of 100, 102, 103, and 104 catchments (see Figure 4)). According to the TRCA guidance document (TRCA, 2017), impact to the catchment of a wetland occurs when the proposal changes the size of the catchment, the amount of impervious cover within the catchment, or when water taking is anticipated to require MECP EASR registration (i.e. >50,000 L/day). The following subsection will evaluate the impact and magnitude of potential changes to the wetland catchment from the proposed development.

3.2 Step 2 – Magnitude of Hydrogeological Change

3.2.1 Impervious Cover

The proportion of impervious cover in the wetlands catchment that would result from the proposal was evaluated using the impervious cover score (S) described in the TRCA Wetland Water Balance Risk Evaluation guidance document (TRCA, 2017). Detailed calculations for impervious cover score are included in Appendix B. The impervious cover score is determined though the following formula:

$$S = \frac{IC * C_{dev}}{C}$$

$Where$:

$$S = impervious\ cover\ score$$

$$IC = \%\ increase\ of\ impervious\ cover\ (\%\ between\ 0\ and\ 100)$$

$$C_{Dev} = total\ development\ area\ of\ the\ catchment\ (ha)$$

$$C = the\ size\ of\ the\ pre\ development\ wetland's\ catchment\ (ha)$$

The value of S is then compared to the 10% and 25% threshold values defining the boundaries between the low, medium, and high magnitude of potential hydrological change categories.

To calculate IC the impervious cover area for pre- and post-development must be calculated. Land use statistics for imperious areas were provided from Jewell Engineering (calculated from OWIT data) and summarized in the Table 1 below.

Table 1 Wetland Catchment Impervious Areas

	Catchments	Catchment Description	Impervious Area (ha)
Pre-Development	100	North	19.5
	102	Southeast	
	103	Wetland	
	104	Off-Site	
Post-Development	A1	South	20.7
	A2	Central development	
	A4	Wetland	
	A5	Northeast	
	A6	Off-Site	
		Difference	1.2

Note: Post Development impervious areas provided by Jewell Engineering with pre-development impervious areas derived using OWIT

The total area of impervious surfaces within the wetland catchment prior to development was calculated to be 19.5 ha and includes sub-catchments 100, 102, 103, and 104 (Figure 4). The total area of impervious surfaces within the wetland catchment, post development, was calculated to increase to 20.7 ha (i.e., 19.5 ha + 1.2 ha), as a result of development within sub-catchments A2 and A5 (Figure 5)

The post development increase in impervious cover was calculated to be 6.3% considering the total impervious area within the wetland catchment (20.7 ha) compared to pre-development conditions (19.5 ha).

The C_{dev} area was calculated to be 45.81 ha and is sum of pre-development sub-catchment areas 100, 102, 103, and 104 and subtracting the delineated wetland area. The area of C was calculated to be 50.75 ha and is sum of the pre-development catchment areas 100, 102, 103, and 104 (see Figure 4).

Therefore, S is calculated as follows:

$$S = \frac{6.3\% * 45.81\ ha}{50.75\ ha} = 5.7\%$$

Since the impervious cover score is less than 10% as per Table 2 in the TRCA Wetland Water Balance Risk Evaluation, the impervious cover score is **Low Magnitude** (TRCA, 2017).

3.2.2 Catchment Size

The wetlands catchment size changing due to development can change the timing, frequency, and volume of runoff reaching the wetland (TRCA, 2017). As a part of the Risk Evaluation, the pre- and post-development wetland catchment size were compared. The pre-development wetlands catchment area was calculated to be 50.75 ha and is the sum of 100, 102, 103, and 104 sub-catchment areas (see Figure 4). The post-development wetlands catchment area was calculated to be 52.26 ha and is sum of the post-development sub-catchment areas A1, A2, A4, A5, and A6 (see Figure 5). Detailed calculations for the pre- and post-development catchments and the change in wetland size are included in the in Appendix B.

The catchment size was calculated to increase 3.0%. The percent change in wetland catchment size was <10%, so as per Table 2 in the TRCA Wetland Water Balance Risk Evaluation (TRCA, 2017), the wetland catchment size change would be considered **Low Magnitude**.

3.2.3 Water Taking – Preliminary Dewatering Estimates

Short term construction dewatering is intended to lower the groundwater levels in the excavation area to ensure a dry and safe working condition.

The requirements for construction dewatering generally depend on the Site's soil and groundwater conditions including soil type, soil permeability or hydraulic conductivity, local groundwater levels, and the design of the proposed development, such as the foundation and/or basement elevation, as well as the size of proposed structure.

3.2.3.1 Excavation Design Parameters

The proposed development includes the construction of single detached houses with proposed foundation areas of 255 m^2. At the time of writing this report, the actual finished floor elevations (FFE), and the detailed design for the structure's basement were not available. It is assumed that the proposed FFE will be approximately the same elevation as the existing grades on Site and that excavations for the basements will be at most 2.5 mbgs (however a recommendation has been made in the Hydrogeological Assessment to minimize the amount of excavations below the water table whenever possible (Cambium, 2024a)). The Site plan included in Appendix A is preliminary and the dewatering estimates will be for buildings basement using several assumptions. Cambium recommends the calculations are revised once detailed designs are available.

Water levels were measured for Cambium's Hydrogeological Assessment from the three monitoring wells on-Site on March 14 and April 19, 2024. Groundwater levels varied from 1.13 to 1.72 mbgs (216.34 to 230.38 masl) on March 14, 2024, and from 0.29 to 0.87 mbgs (217.51 to 231.23 masl) on April 19, 2024, (Cambium, 2024a). The April 19, 2024, water levels are considered representative of spring high groundwater conditions. The highest water level of 0.21 mbgs was used as a conservative measure in the calculations. Assuming the excavations for dwelling basements could go to 2.5 mbgs dewatering would be expected.

The target dewatering depth will be 1 m below the proposed bottom excavation for safe working conditions; therefore, the dewatering drawdown depth is calculated at 3.50 mbgs using the high-water level of 0.29 mbgs at BH109-23. Aquifer thickness for calculation purposes was assumed to be the target depth to groundwater plus 50% of the target drawdown depth at 3.21 mbgs. As the thickness of the overburden aquifer is deeper than the target depth for dewatering. this is considered reasonable as vertical hydraulic conductivities are often an order of magnitude lower than horizontal hydraulic conductivities (Freeze & Cherry, 1979), and water contributions to the excavation from depths deeper than 50% below the target depth of dewatering are assumed to be negligible to minor.

It was known from the development plans that the proposed houses have an area of 255 m^2 and so the length and width of the excavation were taken to be approximately 14 by 19.9 m.

Dewatering calculation parameters for the basement excavations are summarized in Table 2.

Table 2 Summary of Dewatering Calculation Parameters

Excavation	Length (m)	Width (m)	Groundwater Depth (mbgs)	Estimated Excavation Depth (mbgs)	Target Groundwater Depth (mbgs)	Aquifer Base Depth (mbgs)	Drawdown (m)
Basement Excavation	13	19.6	0.21	2.5	3.5	5.11	3.21

A modified Dupuit-Forchheimer equation was used to estimate the dewatering rate required for the proposed rectangular excavation (Powers, Corwin, Schmall, & Kaeck, 2007):

$$Q = \frac{\pi K(H^2 - h^2)}{\ln(R_0/r_s)}$$

$Where$:

$Q \;=\; dewatering\ rate\ (m^3/s)$

$K \;=\; hydraulic\ conductivity\ (m/s)$

$H \;=\; initial\ hydraulic\ head\ in\ aquifer\ (m)$

$h = \; target\ hydraulic\ head\ (initial\ hydraulic\ head - target\ drawdown)\ (m)$

$R_0 \;=\; zone\ of\ influence\ (from\ excavation\ center) = 3000(H-h)\sqrt{K}\ (m)$

$r_s \;=\; equivalent\ single\ well\ radius = width\ of\ trench/2\ (m)$

The radius of influence for each excavation was estimated from soil hydraulic conductivity using the method of Sichardt (1930). In conditions of low hydraulic conductivity, where R_0 is calculated to be less than r_s , the denominator of the first right hand term of the above equation is amended to be $\ln((R_0 + r_s)/r_s)$.

Subsurface shallow soils from Cambium test pit and borehole investigations were described in the Hydrogeological Assessment as a thin layer of silt and sand topsoil (ranging from 0.1 to 0.4 m thick), underlain by silty sand to sand and silt down to 0.6 to 1.5 mbgs (Cambium, 2024a). Also, two borehole logs encountered a clay and silt unit at depths of 0.6 and 1.4 mbgs, which were 1.5 and 1.2 m in thickness respectively. Below these units, the borehole logs generally observed a dense glacial till with either a sandy silt or gravelly sand texture, containing various amounts of clay, gravel, silt, cobbles, and boulders. Glacial till, interpreted as Newmarket Till, was encountered in all boreholes except for BH103-23, which terminated due to auger refusal on a presumed boulder, and BH104-23, which terminated in silty sand.

The hydraulic conductivity for the three monitoring wells BH101-24, BH107-24, and BH109-24 were referenced from the Hydrogeological Assessment for the dewatering estimates. The estimated hydraulic conductivities ranged from 4 x10^{-9} to 2 x 10^{-7} m/s, with a mean of 6 x 10^{-8} m/s. The results are consistent with the hydraulic conductivity values typically found in the Newmarket Till, which has K values ranging from 10^{-6} to 10^{-11} m/s (Sharpe, et al., 1996).

A summary of calculated dewatering rate is provided in Table 3 and detailed analysis reports are included in Appendix C. Based on these results, seepage within the excavation depths should be controllable with filtered sumps and pumps.

Table 3 Calculated Construction Dewatering Rates

Excavation		Hydraulic Conductivity (K)	Zone of Influence (R_0)	Dewatering Rate (Q)		Dewatering Rate (Q) with Safety Factor of 2
		m/s	m	m^3/d	L/d	L/day
Basement Excavation	Minimum	4 x 10^{-9}	0.6	0.4	300	600
	Maximum	2 x 10^{-7}	4.3	3.0	2,900	5,800
	Geometric Mean	6 x 10^{-8}	2.3	1.5	1,400	2,800

Given the maximum hydraulic conductivity of 2 x10^{-7} m/s, the estimated radius of influence for dewatering is 4.3 m for the basement excavations. The maximum estimated construction dewatering rates per basement excavation is 2,800 L/day (2.8 m^3/day). Applying a safety factor of 2, the estimated dewatering for a basement excavation is 5,800 L/day (5.8 m^3/day).

To account for direct precipitation onto the excavations, a 20 mm daily rainfall has been considered based on the City of Toronto Wet Weather Flow Management Guidelines (2006). The total precipitation volume is given by the following formula:

Total Runoff Volume (V) per day = Excavation Area x Rainfall Intensity

Given a footprint for the estimated dwelling basement excavation of 255 m^2, it is possible for an additional 5,100 L/day to accumulate within the construction excavation. Accordingly, the total peak short-term dewatering rate during construction of a single home was estimated at 10,900 L/day.

The safety factor has been applied to account for unforeseen conditions and uncertainty in measured values. This yields a conservative estimate of the pumping rate required to lower or maintain the groundwater levels and provides the dewatering contractor with some flexibility to accommodate circumstances should a higher volume of pumping be necessary. The equation used in dewatering rate estimation is for a steady state condition over the short-term duration of construction. In general, at the beginning of the dewatering pumping operation, the pumping rates will be higher than that the steady state rates, because initially the water stored in the soils is removed before the contribution from the recharge flow is noted.

3.2.3.2 Assessment of Required Regulatory Permits or Registration

Any construction dewatering or other water taking in Ontario is governed by the Ontario Water Resources Act (OWRA; Ontario Regulation 387/04 and/or Ontario Regulation 63/16) and/or the Environmental Protection Act (Registrations under Part II.2).

Where construction dewatering amounts are anticipated to exceed 400,000 L/day, a Permit to Take Water (PTTW) must be obtained. For temporary construction dewatering greater than

50,000 L/day but less than 400,000 L/day, registration through the Environmental Activity and Sector Registry (EASR) is required.

Based on the dewatering rate estimation (includes safety factor of 2 and 20mm rainfall event), for the dwelling basement excavation of 10,900 L/day (10.9 m^3/day), registration on the EASR would not be required. The initial review indicates a water taking permit isn't anticipated, but dewatering estimates should be revisited when detailed design drawings are available for review.

As the dewatering is expected to be less than MECP EASR requirements, and the expected dewatering duration is less than 6 months, as per Table 2 in the TRCA Wetland Water Balance Risk Evaluation, the water taking would be considered **Low Magnitude** (TRCA, 2017).

3.2.4 Impact to Significant Recharge Areas

The MECP Source Protection Information Atlas database was reviewed to determine if the Site is within a significant recharge area. As per the MECP SPIA (Ministry of the Environment, Conservation and Parks, 2024), the Site the south west corner of Site does fall within a Significant Groundwater Recharge Area (SGRA) (see Appendix A; Figure 6).

Cambium test pit and borehole investigations described the surficial soils as a thin layer of silt and sand topsoil, underlain by silty sand to sand and silt (Cambium, 2024a). Below these units, Newmarket till was interpreted to be encountered with either a sandy silt or gravelly sand texture, containing various amounts of clay, gravel, silt, cobbles, and boulders. This indicates that subsurface soils are relatively semi-permeable to impermeable.

The TRCA definition of significant recharge areas are "areas within the wetland's catchment covered by highly porous sedimentary deposits or otherwise having high hydraulic conductivity" (TRCA, 2017). Although mapped as an SGRA, the soils are described in the hydrogeological assessment are not highly permeable and generally have low hydraulic conductivity. Therefore, actual Site conditions may not be conducive to significant groundwater recharge.

Nevertheless, as the proposed development has impervious areas proposed within the mapped SGRA, such as the access road and houses, an SGRA map was overlayed on the Site plan (Figure 6). The SGRA area occupies 1.53 ha of the Site and the Impervious Area Planned within the SGRA is 0.28 ha. Therefore, the percent of impervious area planned within the SGRA is 18% (i.e. (0.28 / 1.53 ha) x 100%).

As per Table 2 in the TRCA Wetland Water Balance Risk Evaluation, the impact to significant recharge areas would be considered Medium Magnitude because the percentage increase is between 10 and 20% (TRCA, 2017).

Although approximately 18% of mapped SGRA on-on site is proposed to be covered by impervious surfaces, water infiltration on-site is expected to increase compared to pre-development conditions due to on-site wastewater effluent disposal (see the water balance results in the Hydrogeological Assessment (Cambium, 2024a)). The impact on the groundwater recharge will be low to negligible as pre-development infiltration rates will be maintained, and impact to the SGRA is not expected. Further detail is included in Cambium's Hydrogeological Assessment report (Cambium, 2024a). Therefore, the impact to significant recharge areas is considered **Low Magnitude**.

3.3 Step 3 – Wetland Sensitivity Analysis

3.3.1 Vegetation Community

The wetland on the Site is comprised of two unique ecosites, namely, White Cedar Mineral Coniferous Swamp (community 3 – SWC1-1), and Red-osier Mineral Thicket Swamp (community 4 – SWT2-5).

Community 4 is identified as having **Low Sensitivity** in accordance with the TRCA guidance document.

3.3.2 Fauna Species

3.3.2.1 Birds

Three OBBA breeding bird surveys were completed at three stations, as shown on Figure 3.

A total of seven bird species exhibited probable or confirmed breeding evidence on the Site or adjacent lands, while thirteen additional birds were observed with possible breeding evidence.

None of these species are listed in TRCA's guidance document.

3.3.2.2 Amphibians

Amphibian breeding surveys were completed at three stations, arranged to capture calling amphibians on the Site as well as in the portion of the wetland on adjacent lands to the west, and along the watercourse at the south end of the Site, as shown on Figure 3.

No amphibian species were detected within or adjacent to the Site.

3.3.2.3 Mammals

Both targeted and incidental surveys confirmed the presence of the following mammals within the Site:

- Eastern Gray Squirrel (*Sciurus carolinensis*);
- Deer (*Odocoileus virginianus; scat*);
- Racoon (*Procyon lotor; tracks*);
- Little Brown Myotis (*Myotis lucifugus)*,
- Northern Myotis (*Myotis septentrionalis*);
- Big Brown Bat (*Eptesicus fuscus*); and,
- Hoary Bat (*Lasiurus cinereus*).

None of these species are identified as sensitive in according to the TRCA guideline.

3.3.2.4 Fish Habitat

Intermittent fish habitat was not confirmed no site; however, it is believed to be probable. Due to significant water level fluctuations and risk of fish mortality, sampling did not occur on site. Sampling was undertaken downstream of the site (Figure 3) using a minnow trap. No fish were captured.

While no fish were confirmed during surveys, it is believed the site may offer marginal fish habitat, occasionally occupied by species tolerant of low dissolved oxygen and higher turbidity levels, such as Brook Stickleback (*Culaea inconstans*).

The TRCA's guidance document identifies Brook Stickleback as having a **Low Sensitivity**.

3.3.3 Flora Species

A total of 38 plant species were observed in the wetland during the ELC and wetland delineation field investigations. Of these, 17 are listed in Appendix 3 of the TRCA guidelines, including 5 species with Low Sensitivity, and 12 with Medium Sensitivity.

Low Sensitivity:

- Broad-leaved Cattail (*Typha latifolia*)
- Meadow Willow (*Salix petiolaris*)
- Purple-veined Willowherb (*Epilobium coloratum*)
- Pussy Willow (*Salix discolor*)
- Spotted Joe Pye Weed (*Eutrochium maculatum*)

Medium Sensitivity:

- Bebb's Willow (*Salix bebbiana*)
- Cottony Willow (*Salix eriocephala*)
- American Water-horehound (*Lycopus americanus*)
- Black Ash (*Fraxinus nigra*)
- Dwarf Raspberry (*Rubus pubescens*)
- Eastern White Cedar (*Thuja occidentalis*)
- Purple-stemmed Aster (*Symphyotrichum puniceum*)
- Sensitive Fern (*Onoclea sensibilis*)

- Spotted Jewelweed (*Impatiens capensis*)
- Swamp Red Currant (*Ribes triste*)
- Water Horsetail (*Equisetum fluviatile*)
- Yellow Marsh Marigold (*Caltha palustris*)

3.3.4 Significant Wildlife Habitat for Hydrological Sensitive Species

The wetland on the Site and adjacent lands has potential to provide Significant Wildlife Habitat (SWH) for:

- *Candidate* Seasonal Concentration Area: Bat Maternity Colonies

  Bat acoustic monitoring confirm the presence of Big Brown Bat on site, an indicator species.

- Habitat for Species of Conservation Concern: Special Concern or Rare Wildlife Species

  Eastern Wood-pewee (Special Concern) was confirmed nesting on site.

In accordance with the TRCA guidance document, species ranked as having high sensitivity *requires increased protection*. Both Big Brown Bat and Eastern Wood-pewee are not listed in the document as a hydrologically influenced species, and therefore these SWH types do not reflect habitat types sensitive to hydrological change.

3.3.5 Hydrological Classification

The wetland on the Site is connected to an intermittent drainage feature expected to carry occasional outflows from the wetland in a southerly direction. Given this connection, the wetland is classified as ‘palustrine’.

Based on criteria in Table 3 of the TRCA guidelines, the palustrine classification is considered in conjunction with the presence of ‘medium’ sensitivity fauna to indicate **high sensitivity** overall.

3.4 Step 4 – Risk Characterization

3.4.1 Assessment of Hydrogeological Change Risk

As summarized in Section 3.2 and below in Table 4, the overall magnitude of hydrogeologic change was determined to be **Low Magnitude**.

Table 4 Summary of Risk Characterization – Magnitude of Hydrogeological Change

Criteria	Magnitude of Hydrogeological Change
Impervious Cover	Low
Catchment Size	Low
Water Taking	Low
Impact to Recharge Areas	Low
Overall Sensitivity Rating	**Low**

Notes: Magnitude of hydrogeological change is based on guidance provided in the TRCA Wetland Water Balance Risk Evaluation guidance document (TRCA, 2017).

3.4.2 Assessment of Wetland Sensitivity Risk

A summary of the criteria used to evaluate the sensitivity of the wetland catchment is provided in Table 5. The overall wetland catchment sensitivity was determined to be **High Sensitivity**.

Table 5 Summary of Risk Characterization – Wetland Catchment Sensitivity

Criteria	Wetland Catchment Sensitivity
Vegetation Community Type (ELC)	Low
High Sensitivity Fauna Species	Low
High Sensitivity Flora Species	Medium
Significant Wildlife Habitat	Low
Hydrological Classification Considering Ecology	High
Overall Sensitivity Rating	**High**

Notes: Sensitivity is based on guidance provided in the TRCA Wetland Water Balance Risk Evaluation guidance document (TRCA, 2017).

3.4.3 Overall Risk Assignment

In summary, the wetland is considered highly sensitive with a low magnitude of hydrogeological change. As per the wetland risk evaluation decision tree (Appendix D) the overall risk would be assigned as **Low Risk**.

The requirements in the decision tree for a Low-Risk assignment detail:

- Monitoring is not required.
- A non-continuous hydrological model (e.g. Thornthwaite Mather) is required with output at monthly or higher resolution.
- A design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012) is required for the Site.

4.0 Conclusion and Recommendations

Cambium was retained by the Yvette Johnston to conduct a TRCA Wetland Water Balance Risk Evaluation at 74 Edwards Drive, Keene, Ontario as a requirement from Otonabee Conservation. The Risk Evaluation was completed in accordance with the applicable TRCA guidelines to inform on the need for additional monitoring/field work in support of the proposed development.

The wetland on-site has an area of 4.94 ha and is comprised of two ecosite units: White Cedar Mineral Coniferous Swamp (SWC1-1) and Red-osier Mineral Thicket Swamp (SWT2-5). The results of the Risk Evaluation indicated the proposed development impact on the wetland catchment is considered to have a low magnitude of hydrogeological change and a high sensitivity for the wetland. The risk characterization based on the decision tree in the TRCA guidance document, characterized the impact of the development on the wetland catchment as **Low Risk**.

It is recommended that this report is considered in conjunction with the hydrogeological Assessment completed concurrently with this report that details a Thornthwaite Mather hydrological model and water balance with mitigation measures to maintain water balance to the wetland.

It is noted that the Hydrogeological Assessment (Cambium, 2024a) indicates that runoff inputs to the wetland on-site will be maintained (and likely increased) upon development of the Site. Therefore, the wetland should no experience a reduction of runoff inputs upon development.

5.0 Closing

We trust that the information in this submission meets your current requirements. If you have any questions regarding the contents of this report, please contact the undersigned.

Respectfully submitted,

Cambium Inc.

DocuSigned by:
6C8CA15FD6B4444...

Warren Young, P.Eng.
Coordinator – Hydrogeologist

DocuSigned by:
F6D1CA3840F04F6...

Jaclyn Rodo, H.B.Sc.
Project Manager – Senior Ecologist

DocuSigned by:
1C0A613349A8482...

Cameron MacDougall, P.Geo.
Project Manager – Hydrogeologist

Signed by:

PROFESSIONAL GEOSCIENTIST
CAMERON J. MacDOUGALL
PRACTISING MEMBER
2676
ONTARIO

2025-02-25

WDY/CJM/JR

\\cambiumincstorage.file.core.windows.net\projects\15800 to 15899\15831-002 Yvette Johnston - HydroGeo - Estate Subdivision\Deliverables\REPORT - TRCA Risk Evaluation\Final\2025-02-07 RPT Wetland Risk Evaluation - 74 Edwards Drive Keene.docx

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7.0 Standard Limitations

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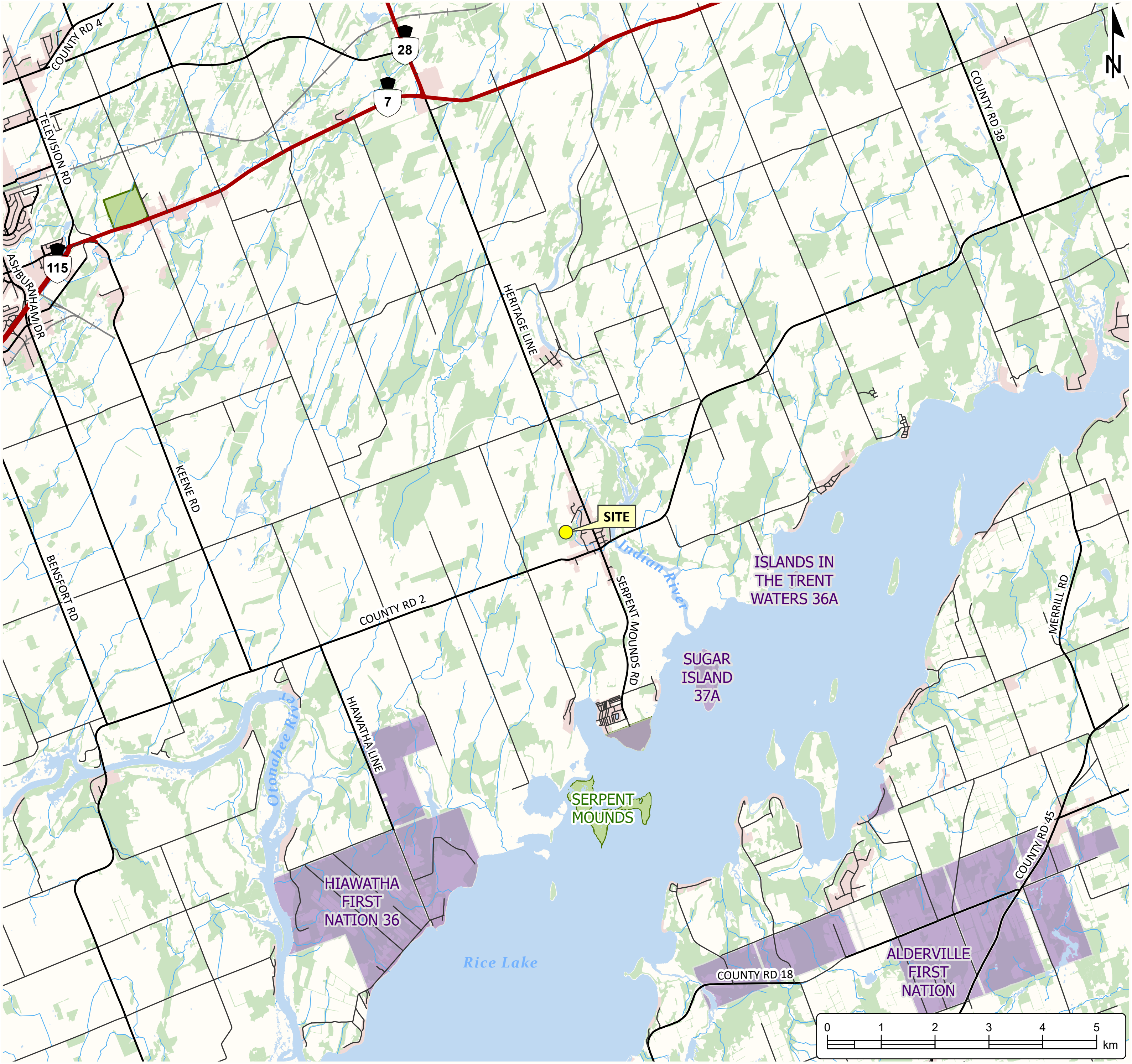
Appended Figures



WETLAND WATER BALANCE RISK EVALUATION

YVETTE JOHNSTON
74 Edwards Drive
Keene, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- First Nations Reserve
- Provincial Park
- Water Area
- Wooded Area
- Built Up Area

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SITE LOCATION PLAN

Project No.: 15831-002	Date: October 2024 Rev.:
Scale: 1:100,000	Projection: NAD 1983 UTM Zone 17N
Created by: LD / Checked by: CM	Figure: 1

WETLAND WATER BALANCE RISK EVALUATION

YVETTE JOHNSTON
74 Edwards Drive
Keene, Ontario

LEGEND

- Benchmark
- Borehole
- Monitoring Well
- Test Pit
- Site (approximate)

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BOREHOLE AND TEST PIT LOCATION PLAN

Project No.: 15831-002		Date: October 2024	
		Rev.:	
Scale: 1:3,000		Projection: NAD 1983 UTM Zone 17N	
Created by: LD	Checked by: CM	Figure: 2	

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Community Number	Description
1	FOD5-2 Fresh Sugar Maple - Beech Deciduous Forest Type
2	CUM1 Mineral Cultural Meadow
3	SWC Coniferous Swamp
4	SWT2-5 Red-osier Mineral Thicket Swamp Type
5	CUW Cultural Woodland
6	FOM4-2 Dry - Fresh White Cedar - Aspen Mixed Forest Type
7	FOM7-1 Moist - Fresh White Cedar - Sugar Maple Mixed Forest Type
8	FOM2-2 Dry - Fresh White Pine - Sugar Maple Mixed Forest Type
9	CUM Cultural Meadow
10	FOM Mixed Forest

WETLAND WATER BALANCE RISK EVALUATION

YVETTE JOHNSTON
74 Edwards Drive
Keene, Ontario

LEGEND

- Minnow Trap 1
- Bat Monitoring Station
- Breeding Bird Survey Station
- Amphibian Survey Station
- Contours (5m Interval)
- Drainage feature
- New Roadway
- Trail
- Watercourse, Permanent
- Vegetation Community
- Field Verified Wetland
- 120m Adjacent Lands
- Site (13.91 ha, approximate)

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NATURAL HERITAGE FEATURES AND ECOLOGICAL SURVEY STATOINS

Project No.: 15831-002	Date: October 2023 Rev.:
Scale: 1:4,500	Projection: NAD 1983 UTM Zone 17N
Created by: LD / Checked by: CM	Figure: 3

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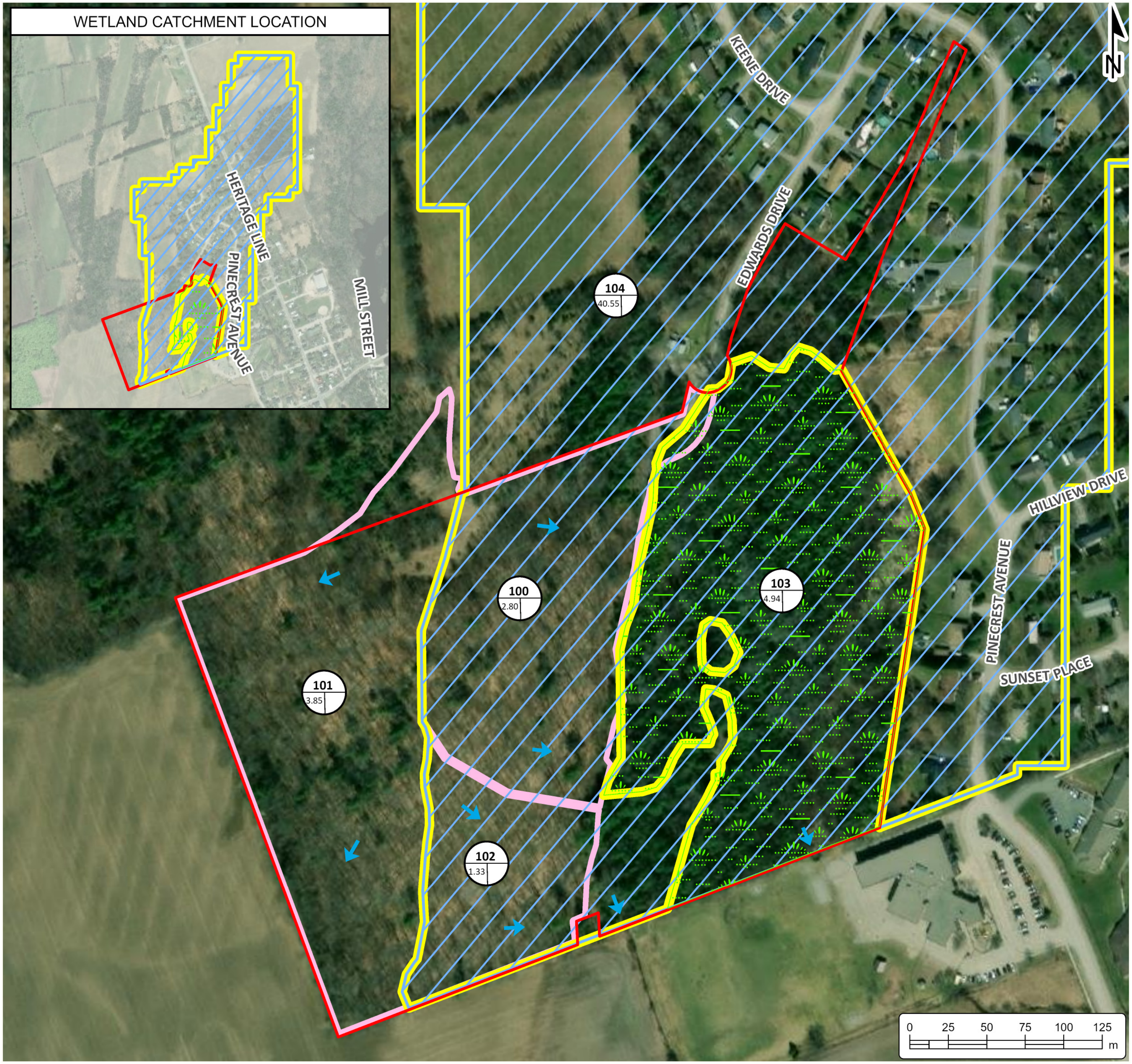

WETLAND WATER BALANCE RISK EVALUATION

YVETTE JOHNSTON
74 Edwards Drive
Keene, Ontario

LEGEND

- Wetland Catchment
- Wetland Catchment (C) (50.75ha)
- Field Verified Wetland (4.94 ha)
- Total Development Area of Catchment (Cdev) (45.81ha)
- Site (approximate)

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PRE-DEVELOPMENT CATCHMENT MAP

Project No.: 15831-002	Date: October 2024 Rev.:
Scale: 1:3,500	Projection:
Created by: LD Checked by: CM	Figure: 4

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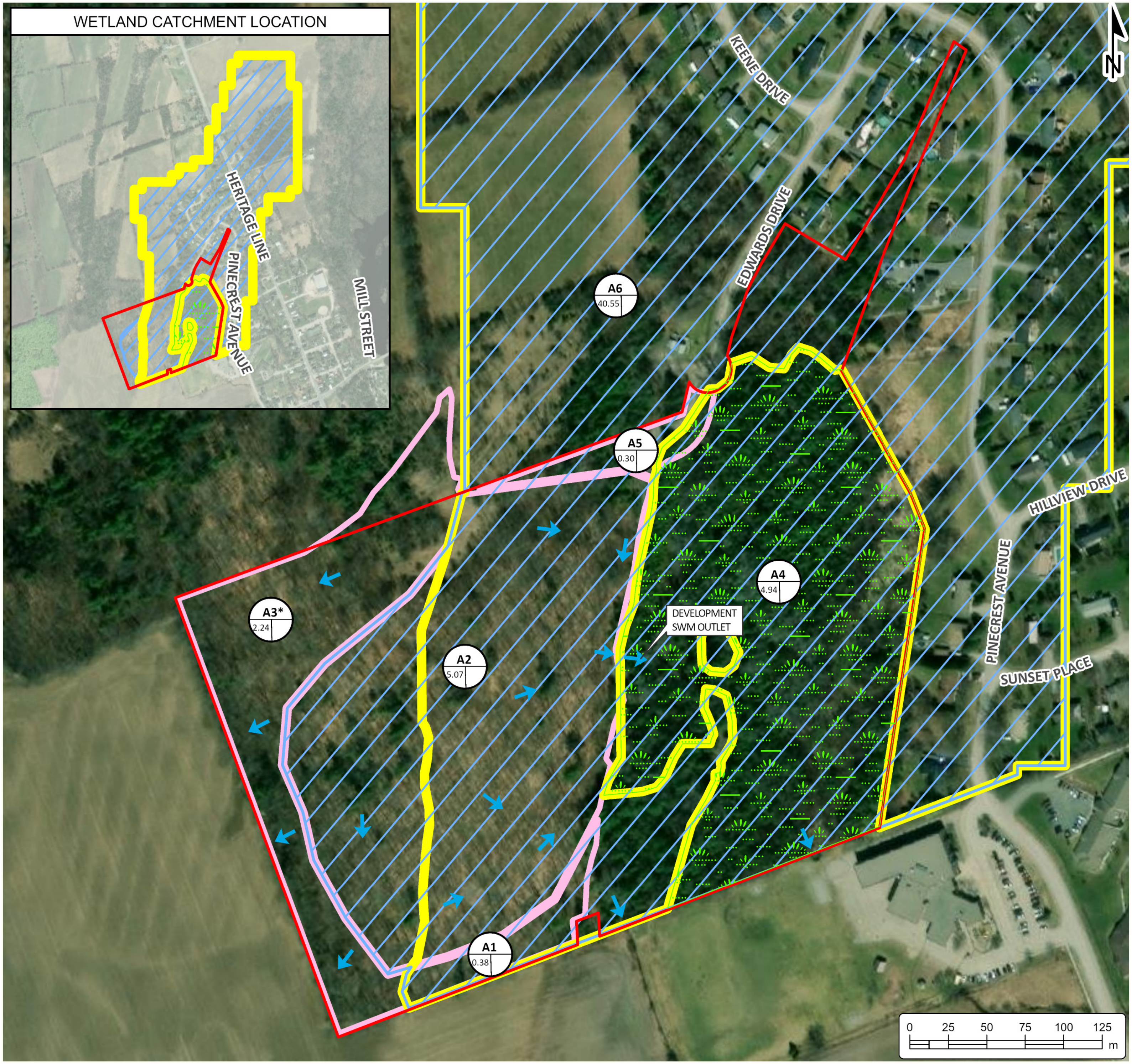

WETLAND WATER BALANCE RISK EVALUATION

YVETTE JOHNSTON
74 Edwards Drive
Keene, Ontario

LEGEND

- Wetland Catchment
- Wetland Catchment (C) (52.26ha)
- Field Verified Wetland (4.94 ha)
- Total Development Area of Catchment (Cdev) (45.81ha)
- Site (approximate)

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POST-DEVELOPMENT CATCHMENT MAP

Project No.: 15831-002	Date: October 2024 Rev.:
Scale: 1:3,500	Projection:

Created by:	Checked by:	Figure:
LD	CM	5

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WETLAND WATER BALANCE RISK EVALUATION

YVETTE JOHNSTON
74 Edwards Drive
Keene, Ontario

LEGEND

- Proposed Impervious Area Within the SGRA (0.28 Ha)
- Proposed Building Footprint (approximate)
- On-Site SGRA (1.53 Ha)
- Site (approximate)

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Tel: (705) 742.7900 Fax: (705) 742.7907
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SGRA MAP

Project No.: 15831-002	Date: January 2025
	Rev.:
Scale: 1:2,750	Projection: NAD 1983 UTM Zone 17N
Created by: LD	Checked by: CM
Figure: 6	

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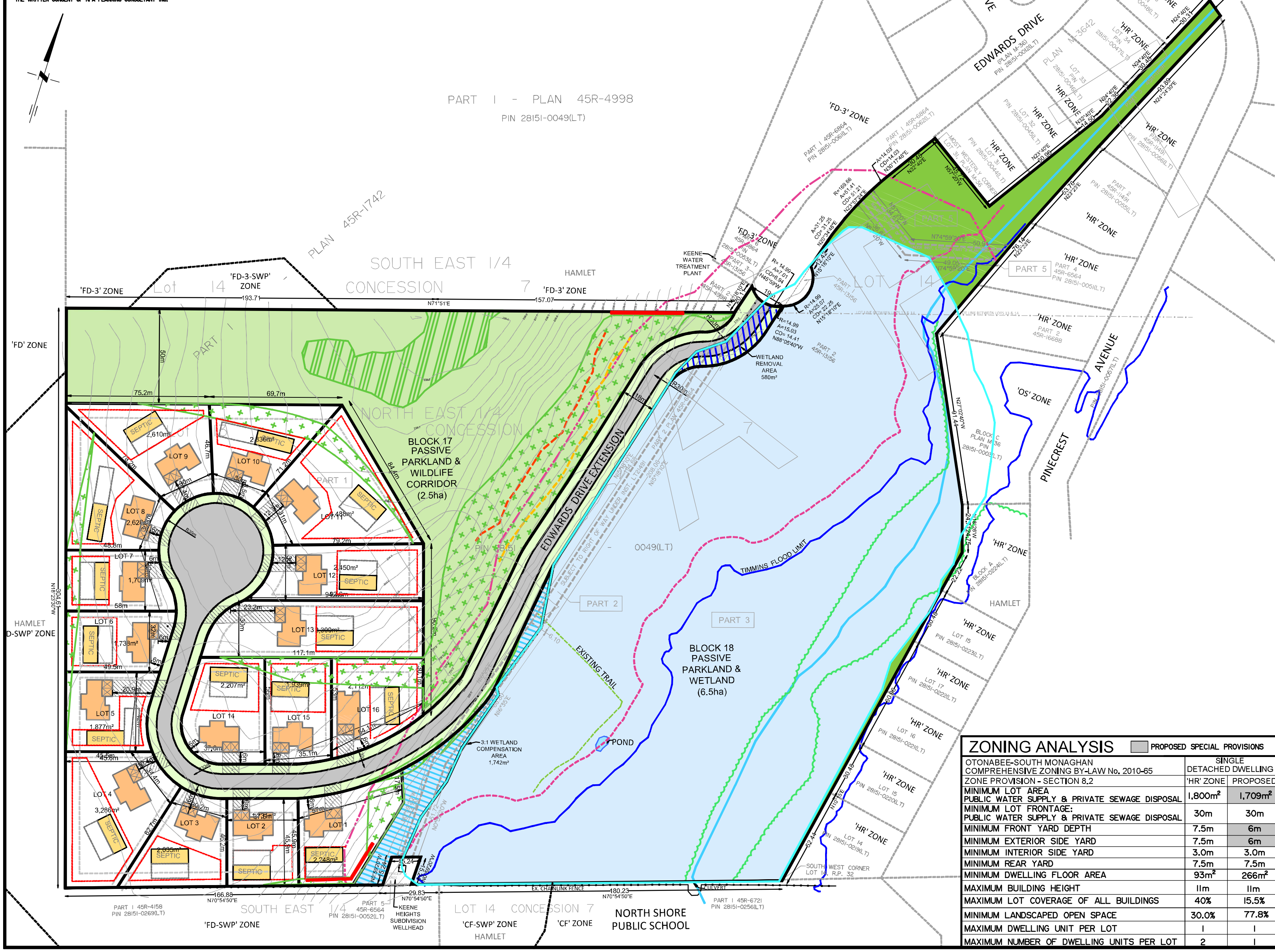
Appendix A

Site Plan and Land Information

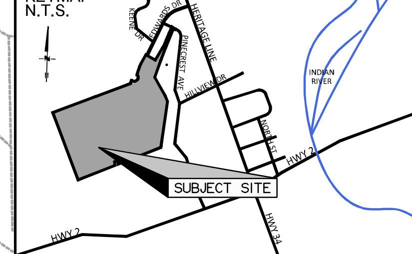


DEVELOPMENT SITE PLAN

PART OF LOT13 & 14, CONCESSION 7
(GEOGRAPHIC TOWNSHIP OF OTONABEE)
PART 4, PLAN 45R-6864 & PARTS 1, 2, 3, 4 & 5 PLAN 45R-14319
SAVE AND EXCEPT PART 2 45R-16688 & PART 1 PLAN 45R-16795
SUBJECT TO AN EASEMENT AS IN LT21491, TOGETHER WITH AN EASEMENT OVER PARTS 1 & 2 PLAN 45R-6864
TOWNSHIP OF OTONABEE-SOUTH MONAGHAN
COUNTY OF PETERBOROUGH

SCALE = 1:2,000 METRIC
0 40 80m

KEYMAP
N.T.S.



LEGEND

- MINERAL CULTURAL MEADOW (CUM1) VEGETATIVE COMMUNITY- TO BE VEGETATED - CAMBIUM 2024
- TEMPORARY TREE REMOVAL AREA TO BE RE-VEGETATED - CAMBIUM 2024
- SURVEYED EXISTING WETLAND - CAMBIUM, 2022
- WETLAND REMOVAL AREA (580m²)
- 3:1 WETLAND COMPENSATION AREA (1,742m²)
- POTENTIAL PRIMARY SEPTIC LOCATION - CAMBIUM, 2024
- POTENTIAL SINGLE-DETACHED DWELLING
- POTENTIAL DRIVEWAY LOCATION
- TIMMINS FLOODLINE - JEWELL, 2024
- EXISTING NATURAL TRAIL
- 15m FLOODLINE SETBACK
- 30m WETLAND SETBACK
- WATERCOURSE
- EXISTING EASEMENT LINES
- PROPOSED RETAINING WALL
- TOP OF SLOPE - CAMBIUM, 2022
- BOTTOM OF SLOPE - CAMBIUM, 2022
- POTENTIAL SEPTIC RESERVE LOCATION - CAMBIUM, 2024

LAND USE SUMMARY

LAND USE SUMMARY	AREA(ha.)	AREA%	UNITS
SINGLE-DETACHED RESIDENTIAL LOTS	3.78	26.9	16
MUNICIPAL ROAD ALLOWANCE	1.27	9.0	
PASSIVE PARKLAND WITHIN WETLAND	5.93	42.1	
PASSIVE PARKLAND OUTSIDE OF WETLAND	3.12	22.0	
TOTAL	14.10ha	100.0%	16

PARKLAND SUMMARY

PASSIVE PARKLAND WITHIN WETLAND	5.93
PASSIVE PARKLAND OUTSIDE OF WETLAND	0.62
WILDLIFE CORRIDOR - OUTSIDE WETLAND	2.5
PARKLAND TOTAL	9.05ha

NOTE:

METRIC NOTE:
DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

BUILDING NOTE:
BUILDING FOOTPRINTS, LANDSCAPED OPEN SPACE AND DRIVEWAYS ARE CONCEPTUAL AND SUBJECT TO CHANGE.

SURVEY NOTE:
DRAWING CREATED USING DATA FROM PLAN 45R-14319 BY BENINGER SURVEYING LTD. DATED FEBRUARY 12 2008 CONTOUR DATA PROVIDED BY JEWEL ENGINEERING.

ZONING ANALYSIS

PROPOSED SPECIAL PROVISIONS

OTONABEE-SOUTH MONAGHAN COMPREHENSIVE ZONING BY-LAW No. 2010-65	SINGLE DETACHED DWELLING	
ZONE PROVISION - SECTION 8.2	'HR' ZONE	PROPOSED
MINIMUM LOT AREA PUBLIC WATER SUPPLY & PRIVATE SEWAGE DISPOSAL	1,800m²	1,709m²
MINIMUM LOT FRONTAGE: PUBLIC WATER SUPPLY & PRIVATE SEWAGE DISPOSAL	30m	30m
MINIMUM FRONT YARD DEPTH	7.5m	6m
MINIMUM EXTERIOR SIDE YARD	7.5m	6m
MINIMUM INTERIOR SIDE YARD	3.0m	3.0m
MINIMUM REAR YARD	7.5m	7.5m
MINIMUM DWELLING FLOOR AREA	93m²	266m²
MAXIMUM BUILDING HEIGHT	11m	11m
MAXIMUM LOT COVERAGE OF ALL BUILDINGS	40%	15.5%
MINIMUM LANDSCAPED OPEN SPACE	30.0%	77.8%
MAXIMUM DWELLING UNIT PER LOT	1	1
MAXIMUM NUMBER OF DWELLING UNITS PER LOT	2	1

No.	REVISION	DATE	APPR'D

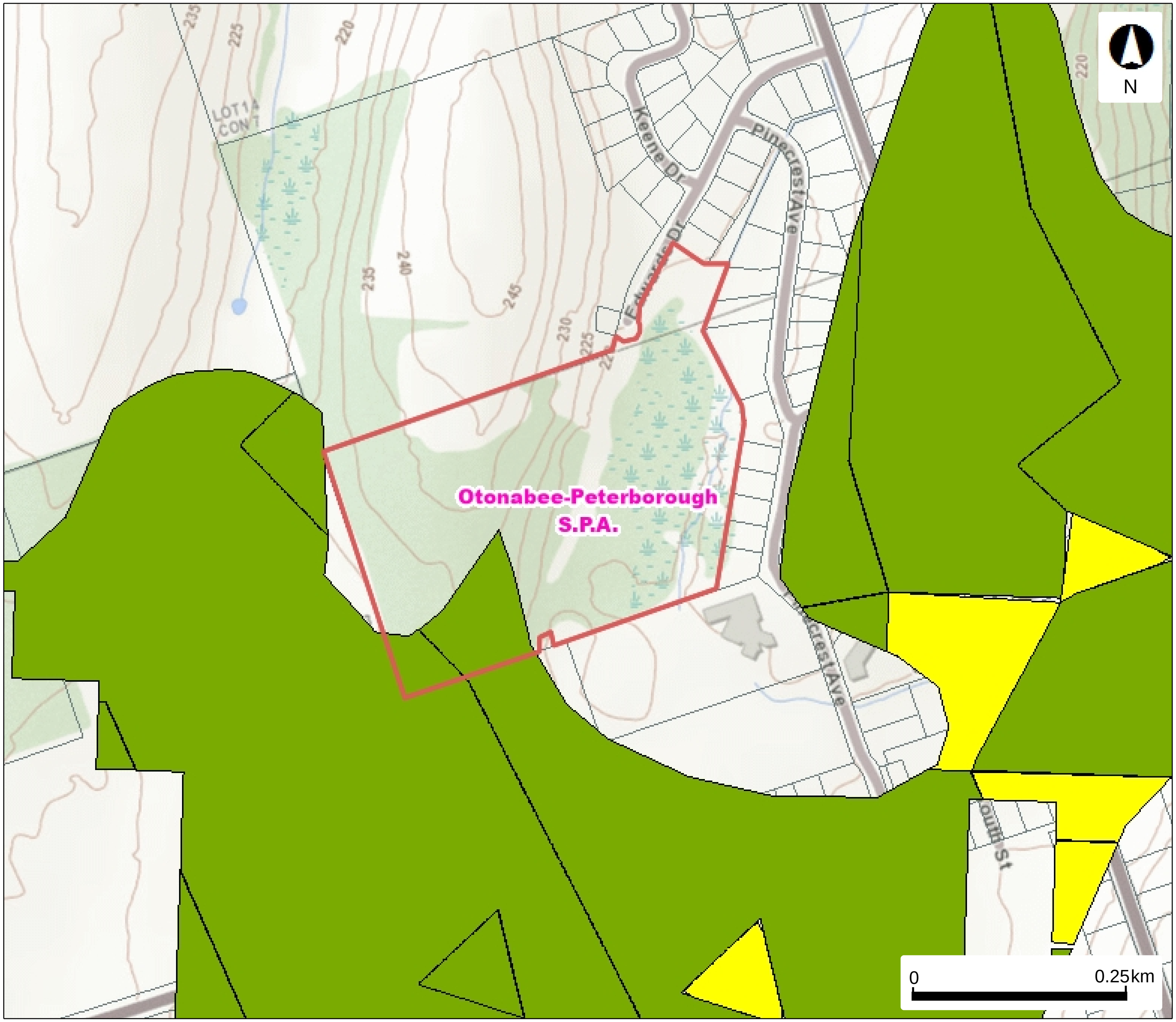
DRAWN BY: F.M. | CHECKED BY: S.L. | DATE: JANUARY 23, 2025 | SCALE: 1:2,000

JAN 23, 2025

RFA PLANNING CONSULTANT INC
211 Dundas Street East, Suite 202,
Belleville, Ontario, K8N 1E2

JOB No. 888

SGRA Map



Legend

Significant Groundwater Recharge Area

- N/A
- 0
- 2
- 4
- 6

Source Protection Areas

Assessment Parcel

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

Ontario

THIS IS NOT A PLAN OF SURVEY.

Map Created: 9/20/2024

Map Center: 44.243 N, -78.16893 W

Appendix B

Risk Evaluation – Hydrogeologic Change Calculations

CAMBIUM

Wetland Water Balance Risk Evaluation:
Magnitude of Potential Hydrogeological
Change Calculations

74 Edwards Drive, Keene, Ontario
Yvette Johnston
Cambium Reference: 15831-002

Pre Development Catchments

Catchment	Description	Area (ha)
100	Northeast	2.80
101	West	3.85
102	Southeast	1.33
103	Wetland & Eastern Area	6.07
104	Off-Site	40.55
Sum		**54.6**

Post Development Catchments

Catchment	Description	Area (ha)
A1	South	0.38
A2	Central Development	5.07
A3	West	2.24
A4	Wetland & Eastern Area	6.07
A5	Northeast	0.30
A6	Off-Site	40.55
Sum		**54.6**

Impact to Recharge Areas

Description	Area (ha)
Proposed Impervious Area Within the SGRA	0.27
On Site SGRA Area	1.53
% SGRA Area Replaced by Impervious Cover	**17.6%**

10 - 25% = MEDIUM MAGNITUDE

Change in Wetland Catchment Size

	Catchments Included	Area (ha)
Pre-Development	100, 102, 103, 104	50.75
Post-Development	A1, A2, A4, A5, A6	52.26

% Increase in Catchment Size **3.0%**
<10% = LOW MAGNITUDE

Impervious Cover Score (S)

Parameters	Notes	Area (ha)
C	Pre-Development Wetlands Catchment	50.75
Wetland Area	As deliniated in 2024 EIS	4.94
C_{dev}	Pre-Development Wetlands Catchment Area - Wetland Area	45.81
Exisiting Impervious Area in C	Pre-Development Impervious Surface Area from OWIT	19.5
Proposed Additional Impervious Area in C	Proposed roads, driveways, roofs area	1.2
Total Post Development Impervious Area in C	Pre -Development Impervious Surface Area from OWIT + Proposed Additional Impervious Area in C	20.7

(1) Note: Impervious areas provided by Jewell Engineering with Pre-Development Impervious Areas derived using OWIT

IC = ((Total Post Dev. Imperv. Area) - (Pre Dev. Imperv. Area)) / (Pre Dev. Imperv. Area) ***6.3%***

$$S = \frac{IC * C_{dev}}{C} \qquad S = \frac{6.3 * 45.81\ ha}{50.75\ ha} \qquad S = \mathbf{5.7\%}$$

S is less than 10% = LOW MAGNITUDE

where:
S= impervious cover score
IC = proportion of impervious cover planned within wetlands catchment
C_{dev} = total development area of the wetlands catchment (not including wetland and buffer)
C= the size of the pre development surfacewater catchment of the wetland

Appendix C

Dewatering Calculations

CAMBIUM

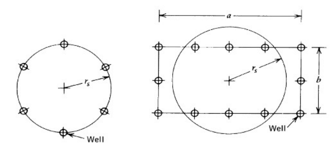
DEWATERING CALCULATIONS - DWELLING

Modified Dupuit-Forchheimer Equation: unconfined flow into a rectangular excavation.
Calculations assume no flow boundary at aquifer base

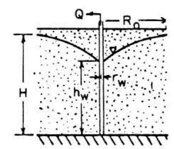
Excavation Area		Initial Depth to Groundwater	Target Depth to Groundwater	Depth to Base of Aquifer*	Excavation Length (a)	Excavation Width (b)	Hydraulic Conductivity (K)	Drawdown (s)	R	$r_w = \sqrt{(ab/\pi)}$	R_o	$\ln(R_o/r_w)$	H	h_w = H-s	Q_{total}		
		mbgs	mbgs	mbgs	m	m	m/s	m	m	m	m	-	m	m	m^3/s	L/s	L/d
Rectangular excavation with dimensions axb	Minimum K	0.29	3.5	5.11	13	19.6	4.0E-09	3.21	0.61	9.01	9.61	0.07	4.82	1.61	**0.000004**	**0.00**	**342**
	Maximum K	0.29	3.5	5.11	13	19.6	2.0E-07	3.21	4.31	9.01	13.31	0.39	4.82	1.61	**0.000033**	**0.03**	**2,862**
	Geometric mean K	0.29	3.5	5.11	13	19.6	6.0E-08	3.21	2.36	9.01	11.36	0.23	4.82	1.61	**0.000017**	**0.02**	**1,443**

s = target drawdown (initial - target depth to groundwater) (m)
R_o = radius of influence of construction dewatering/pumping, from center of excavation (m)
r_s = equivalent single well radius (m)
H = Initial hydraulic head in aquifer (m)
h = hydraulic head at radius of well (m)
Q = construction dewatering rate (m^3/s)
*For base of aquifer, use target depth to groundwater plus 50% of target drawdown (s), unless specific geological conditions dictate otherwise.

For practical use, R is presented as zone of influence for reporting purposes, with the distance defined from edge of excavation.



$$r_s = \sqrt{\frac{ab}{\pi}}$$



Radial flow, water table aquifier

$$Q_w = \frac{\pi K(H^2 - h_w^2)}{\ln R_0 / r_w}$$

(from Table 6.1, pg 67)

*Use $r_w = r_s$ for rectangular excavations

Source: Powers, J. Patrick, et al. "Construction dewatering and groundwater control." (2007)

R = 3000*s*sqrt(K)

Source: Kyrieleis, W. and Sichardt, W. "Grundwasserabsenkung bei Fundierungsarbeiten" Springer, Berlin, 1930

R_o = R, if R >> r_s *(R >> rs when R/r_s > 100)*
else, R_o = R + r_s

Source: Cashman and Preene. "Groundwater Lowering in Construction." (2013)

Appendix D

TRCA Wetland Risk Evaluation Decision Tree

1

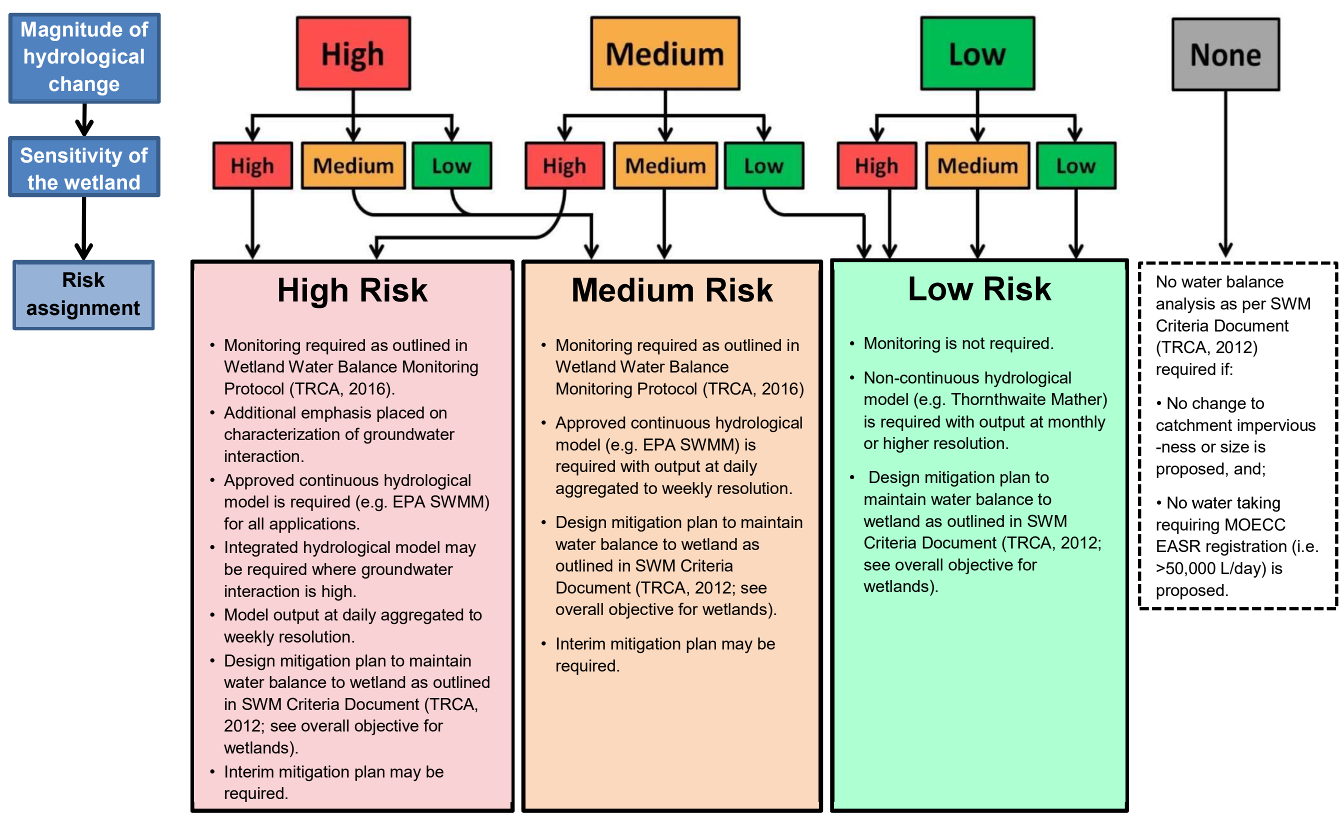


Figure 3: Wetland Risk Evaluation Decision Tree