Environmental Impact Study

FOR AN

All-Terrain Vehicle Crossing of a Small Wetland

EAST HALF OF LOT 29 CONCESSION 3, BELMONT TOWNSHIP

PREPARED BY

Gary S. Bowen

Retired Watershed Specialist and Great Lakes Advisor

Toronto and Region Conservation Authority

WITH INPUT FROM

Mr. Bruno Dobri

Dobri Engineering

Port Hope, Ontario

Dr. William Booty

Retired Research Scientist

Environment Canada

JANUARY 7, 2025

SUMMARY

The investigation and analysis of relevant environmental data—combined with the required “professional” reviews of the proposed crossing location, the suitability of local fill materials, the crossing design, and construction methodologies—all indicate there are no constraints that would preclude building this ATV crossing. The requested engineering review has confirmed there will be no hydrologic impacts and the sized culvert can safely convey flood flows.

Operation and maintenance practises outlined for the ATV crossing will ensure there will be minimal disturbances to adjacent wetlands.

INTRODUCTION

A legal land survey of the northern property line between Lots 29 and 30 in 2022 determined the existing private All-Terrain Vehicle (ATV) trail was not on our property. This crossing has been in use for over 30 years without impacting the wetland. A new ATV crossing is required downstream on our property.

An ATV crossing of a wetland constructed with a trail bed built with locally sourced materials and a properly sized culvert should be preferred over multiple uncontrolled ATV crossings of a wetland, and as site water level conditions necessitate, draining the downstream wetland.

In early 2024, a meeting was held at Crowe Valley Conservation Authority (CVCA) office to discuss details pertaining to a permit application for the ATV crossing. Following this meeting, a site visit was arranged for May 22, 2024.

CVCA staff were met at the end of McMillian Road and guided on foot to the crossing site. CVCA staff took photographs and videos of the crossing site. Inspection of the crossing site involved walking most of the way across the wetland stopping at the creek. Information on the adjacent wetlands and hydrology of the drainage system were discussed on site along with the proposed construction techniques.

At the end of the site inspection, CVCA staff were notified that a preliminary application would be submitted for further consultation and for staff assistance in determining the fill fee.

On May 27, 2024, a preliminary submission was submitted to the CVCA for a permit application: (085/24M) Fire Road 59 (ARN: 1531 010 006 49300), Part Lot 29 Concession 3, Belmont Township, for a private ATV trail crossing of a small wetland.

On June 19, 2024, an email was received from CVCA staff denying the permit. CA staff said they could support, as an alternative, an elevated boardwalk. Staff also indicated the wetland development application could proceed by pursuing the permit via a Watershed Advisory Board Hearing. Staff recommended some additional studies that would be required for the hearing.

As responsible landowners, a revised an application for a crossing permit is being submitted to CVCA along with this Environment Impact Study (EIS).

The EIS was prepared by Gary Bowen, a retired watershed and Great Lakes scientist previously employed at the Toronto and Region Conservation Authority and the Ontario Ministry of The Environment.

Dr. William Booty, a retired Research Scientist (Environment Canada), and Mr. Bruno Dobri, P. Eng., were retained to address CVCA request that qualified professionals undertake the following reviews:

- Demonstrate that hydrological function of the wetland will not be impacted
- Assess the proposed culvert to determine adequate sizing
- Assess soil conditions where the trail is proposed and any proposed construction recommendations

STUDY AREA

The Site Map for the ATV crossing permit is depicted in **FIGURE 1**, prepared by Dobri Engineering. A more detailed map of the wetland crossing location prepared using the Peterborough County GIS Map 2.0 is presented in **FIGURE 2**. **FIGURE 3** is a recent image from Google Earth showing the location of the proposed new ATV crossing.

Active coordinates for Ontario Intensity Duration Frequency (IDF) DF Curve look up are:

44° 34' 45" N 77° 55' 44" W (44.579167, -77.845833)

The legal description of the property for this permit application is :

085/24M Fire Road 59 (ARN: 1531 010 006 49300)
Part Lot 29 (East) Concession 3, Belmont Township

This property has been in family ownership since 1929.

FIGURE 1

SITE MAP

DOBRI ENGINEERING

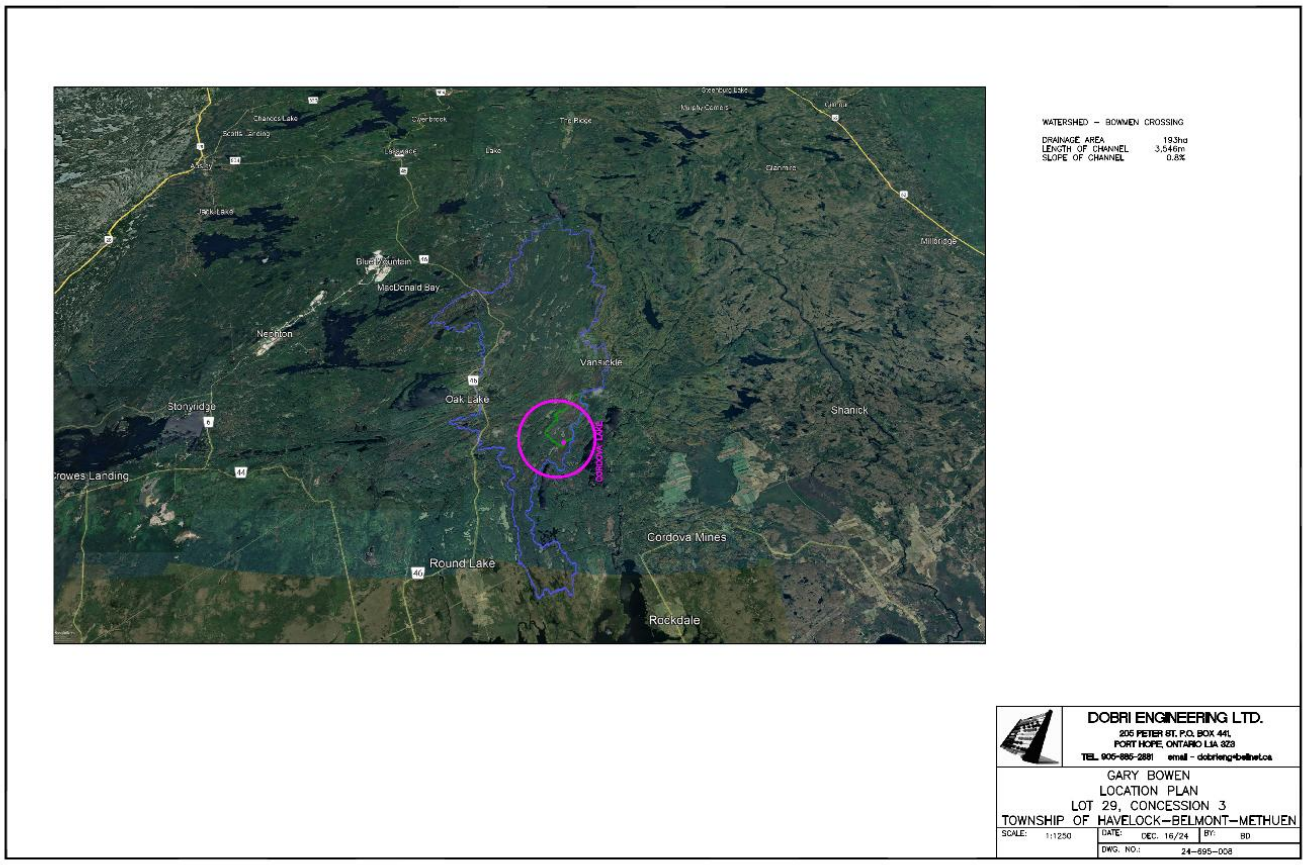


FIGURE 2

LOCATION OF CROSSING IN RED

PETERBOROUGH COUNTY GIS MAP 2.0

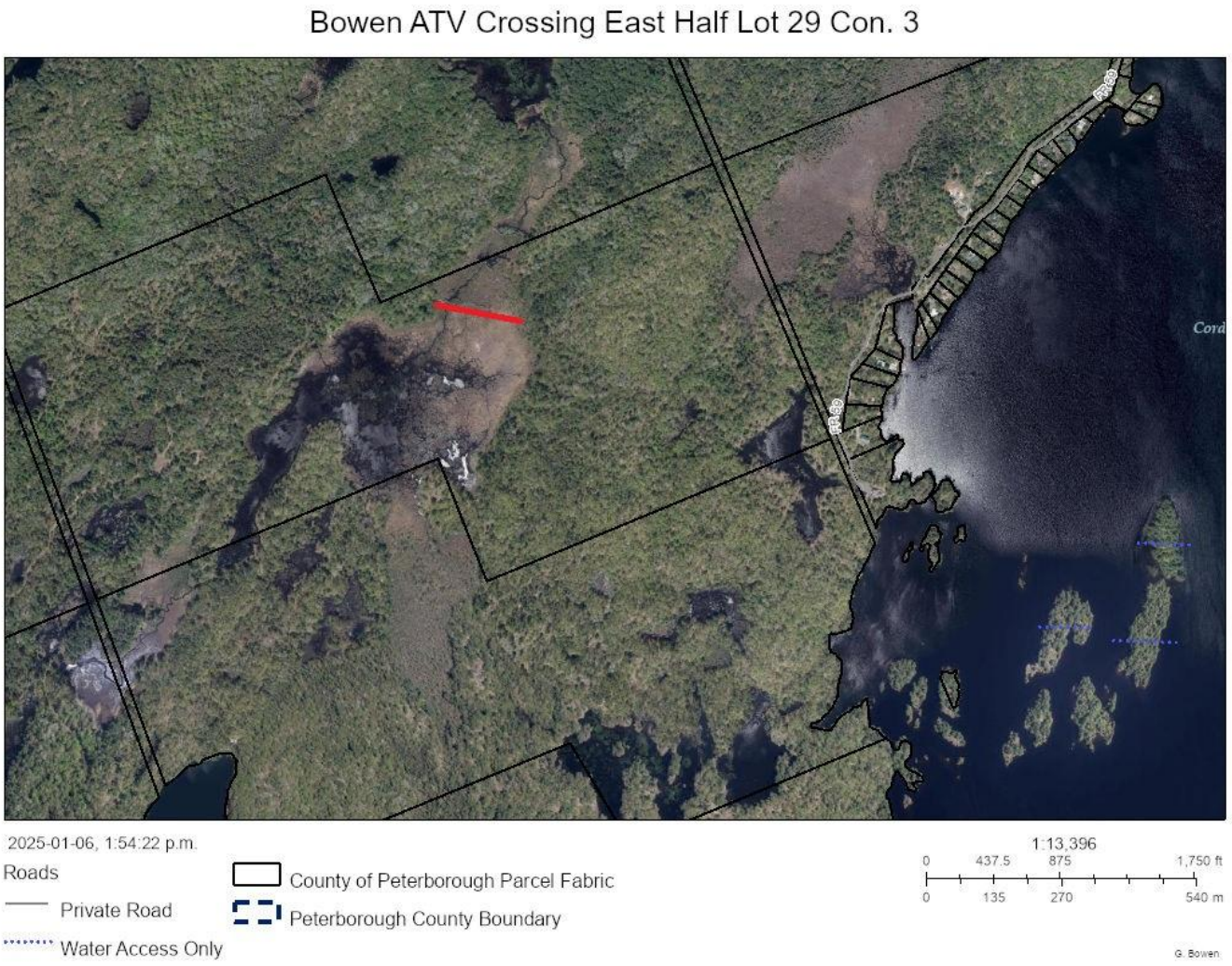


FIGURE 3

LOCATION OF PROPOSED ATV CROSSING

GOOGLE EARTH (2022)

CROSSING DESIGN AND CONSTRUCTION SPECIFICATIONS AS PER BOWEN PERMIT APPLICATION

Details on the crossing design were provided to CVCA at the initial meeting and in the preliminary application. This replacement wetland crossing will be 130 m long, 4 m wide, and built upon a bed of fill up to 1 m in depth.

Several reference documents for road construction and water crossing designs of swamps were reviewed for this design. These documents were prepared by various provincial agencies in consultation with utility operators, logging and mining officials, and local municipal road department superintendents. Additional guidelines for working around wetlands prepared by Ducks Unlimited were considered.

Further, our own knowledge and expertise were utilized. Gary and John Bowen have over 30 years of relevant professional experience. Gary was employed as a private sector consultant and scientist with the Ontario Ministry of Environment and the Toronto and Region Conservation Authority. John worked his entire career for Ontario Hydro as a Forestry Supervisor responsible for environmental oversight of transmission line right of ways across the province.

TABLE 1 **CROSSING SPECIFICATIONS**
BOWEN APPLICATION
LOT 29 CONC. 3 BELMONT TWP.

TIMING The crossing will be installed when the site is as dry as possible and has maximum vegetation cover. Water levels can be manipulated through removing portions of the downstream beaver dam if necessary.

RETENTION OF EXISTING VEGETATION MATT
The crossing will be constructed on top of vegetation.

EXISTING BEAVER DAM
The dam will be incorporated into the crossing where it aligns.

CONSTRUCTION METHODOLOGY

- Fill will be locally sourced from pits located a minimum of 30 m from the edge of the wetland.
- Several types of fill will be piled and made available to use where appropriate.
- Prior to construction, silt fencing will be placed upstream and downstream of the proposed work site.
- Prior to construction, a straw bale sediment trap will be placed immediately downstream of the location the culvert will be installed at.
- The culvert will be at minimum 60 cm in diameter and 5 m long.
- Rip rap will be placed on the upstream end of the culvert.
- A layer of stone will be placed first in the location of the culvert prior to installation so that the culvert is just slightly lower (10%) than the bottom of the existing creek.
- A beaver grate will be placed on the upstream culvert intake immediately after installation.
- Filter fabric will be placed on top of existing vegetation on the first and last 10–15 meters of the crossing, then sand/gravel fill will be added as required.
- Prior to placing fill on the remainder of the crossing, full-length trees (minus limbs) may be placed on top of the undisturbed vegetation to form corduroy.
- Filter fabric and/or limbs will be installed on top of the corduroy, then fill to an approximate depth of 1 m.
- Should it be necessary to use corduroy, all exposed wood will be covered.
- Upon completion of the crossing, the straw bale and silt fence will be retained for 3–4 weeks until vegetation cover on disturbed areas is re-established.
- Native vegetation will quickly grow back on the site; seeding with non-native pasture mixes etc. is not recommended.

FIGURE 4 is a schematic illustrating the crossing design. Since this ATV trail crossing does not require an engineering drawing, a sketch was prepared based upon a variety of recommended techniques, as documented in the reviewed crossing guidelines.

The location of the crossing site was inspected by Dr. William Booty. Dr. Booty has approved the site and the suitability of locally sourced materials for the trail and construction. (**APPENDIX 1**)

Mr. Bruno Dobri, P. Eng., reviewed the crossing specifications and relevant local information as described in this EIS and submitted to the CVCA in our preliminary permit application. He reports no concerns in terms of hydrologic impacts and provided the requested engineered culvert sizing. Mr. Dobri has recommended that the crossing incorporate the existing beaver dam, where the construction alignment permits. (**APPENDIX 2**)

Equipment Operators hired to construct the crossing have been trained to work safely around water and are familiar with the requisite sediment and erosion controls. It is our recommendation that these equipment operators be allowed some flexibility to make minor modifications if unique site conditions are encountered.

John and Gary plan to be on site when the crossing is constructed to ensure the heavy equipment contractor adheres to all permit requirements.

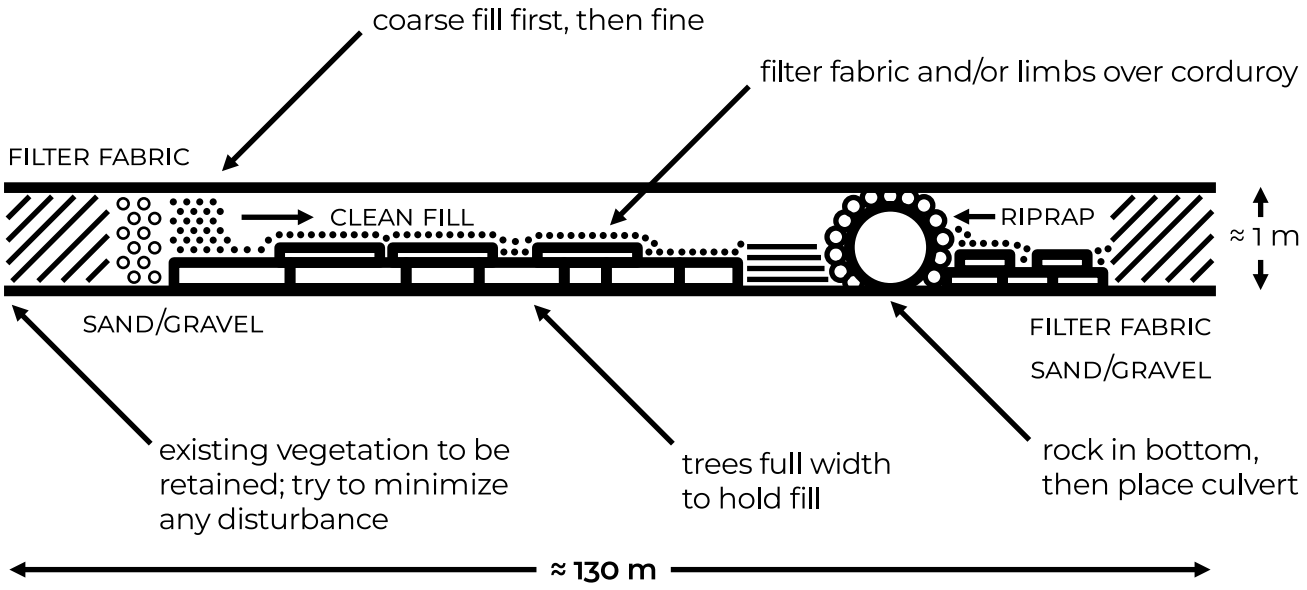
Post-construction site inspections will be carried out by ourselves. John and Gary have the professional qualifications to undertake this task, based upon our past work experience and environmental training. John was responsible for Ontario Hydro's right of way erosion controls. While employed at Ontario Ministry of Environment, Gary Bowen was involved in the development of the first stormwater water quality guideline and early versions of provincial sediment and erosion control guidelines for urban development.

Long-term oversight of the ATV crossing site will be undertaken by Robert Bowen; retired from Ontario Power Generation, he was responsible for operating hydroelectric power stations across the province. His duties as an Operating Supervisor included regulating water levels at these dam sites. Robert is a licensed fur trapper and when necessary, will control local beaver populations and/or remove sections of the downstream beaver dam to lower water levels following excessive runoff conditions.

FIGURE 4

CROSSING DIAGRAM

BASED ON SKETCH PREPARED BY JOHN BOWEN ON JULY 21, 2024



DESCRIPTION OF WETLANDS IN PROXIMITY OF THE ATV CROSSING

There are five wetlands near the crossing site. These wetlands are illustrated in **FIGURE 5**, which also includes ,in tabular format, relevant information for each wetland. The crossing site is in wetland #3 as indicated on the drawing. All five wetlands are unevaluated. Neither wetland #3 nor the other four interconnected wetlands are identified as being Provincially Significant, a bog, or a fen.

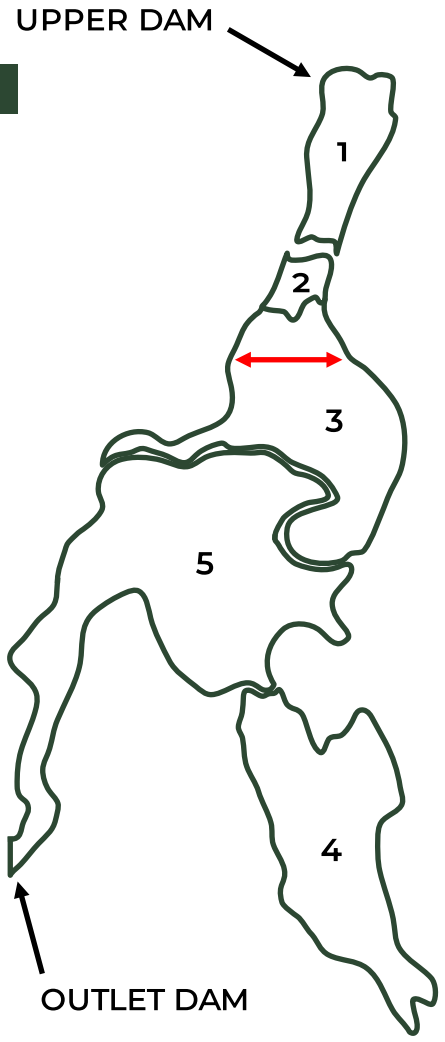
The five wetlands depicted in **FIGURE 5** are interconnected due to local topographic features and by water level control through beaver dams (at the outlet and upstream of the crossing site). The total surface area for the five wetlands is 24.1 ha. Wetland #3 (OGFID #70967387) has an area of 5.11 ha, which is about 24% of the (five) total wetlands.

FIGURE 5

WETLANDS IN PROXIMITY OF THE PROPOSED CROSSING

PROPOSED CROSSING IN RED

WETLAND	OGFID	AREA (m^2)	% OF AREA
1	70967332	16,807.3	7.9
2	70967376	4,431.9	2.1
3	70967387	51,164.5	23.9
4	70967473	51,929.8	24.3
5	70977415	89,748.8	41.9
	TOTAL	214,082.3	



PHOTOGRAPH 1 is a drone picture of wetland #5, showing a viewpoint downstream from the crossing site. The outflow channel from wetland #3 is apparent. This photograph was taken in 2022 (a drought year).

PHOTOGRAPHS 2 and **3**, both taken in 2024, illustrate the creek channel at the ATV crossing site (a view looking upstream from the crossing site).

PHOTOGRAPH 4 illustrates the local wetland vegetation community.

PHOTOGRAPH 5, taken from the top of the crossing site beaver dam, looks over wetland #5 towards the embayment (wetland #4) off to the southeast.

PHOTOGRAPH 1

DRONE PHOTO, WETLAND #5

2022

PHOTOGRAPH 2

CREEK AT PROPOSED CROSSING

SPRING 2024

PHOTOGRAPH 3

CREEK CHANNEL

SUMMER 2024

PHOTOGRAPH 4

VEGETATION AT PROPOSED CROSSING SITE

PHOTOGRAPH 5

TOP OF CROSSING BEAVER DAM LOOKING DOWNSTREAM

SEPTEMBER 2024

TOPOGRAPHIC FEATURES

Local topographic relief for the study area can be downloaded as high-resolution depictions of terrain elevations via the Canada Maps App (Google Play). This mapping app uses digital elevation data layers provided by Natural Resources Canada's Canadian Elevation Model which is based on airborne LIDAR. For this Digital Terrain Model (DTM) data sets, derived mapping for the crossing site include slope, aspect, shaded relief, colour relief and colour shaded relief.

The High-Resolution Digital Terrain Model illustrated in **FIGURE 6** is so detailed that all the beaver dams, creek channels, and emergent vegetation margin lines are depicted. This image provides an excellent perspective of the terrain features at the crossing site. It illustrates that wetland vegetation and glacial and lacustrine deposited sediments afford a good base for construction.

Detailed elevation profiles at the crossing site suggest a minimal number of trees and fill will be deposited in the wetland to secure a hard road base for the ATV trail. Additional DTM layers were obtained for the crossing site from the Peterborough County GIS platform and overlain with 2 m contours to assist Mr. Dobri in evaluating water level responses to the ATV trail bed profile (**FIGURE 7**).

Colour slope perspective images showcase the terrain features around our property (**FIGURE 8**) and afford a 3D perspective of local relief, with blue–black colours for the lowest elevations (deeper water areas in the wetlands). Yellow or pink colours present steep slopes aligned with rock ridges in the higher elevations. Of note are the abundance of depressions (wetlands) in this digital image.

FIGURE 6

DIGITAL TERRAIN MODEL: WETLANDS ADJACENT TO PROPOSED CROSSING

PROPOSED CROSSING IN RED

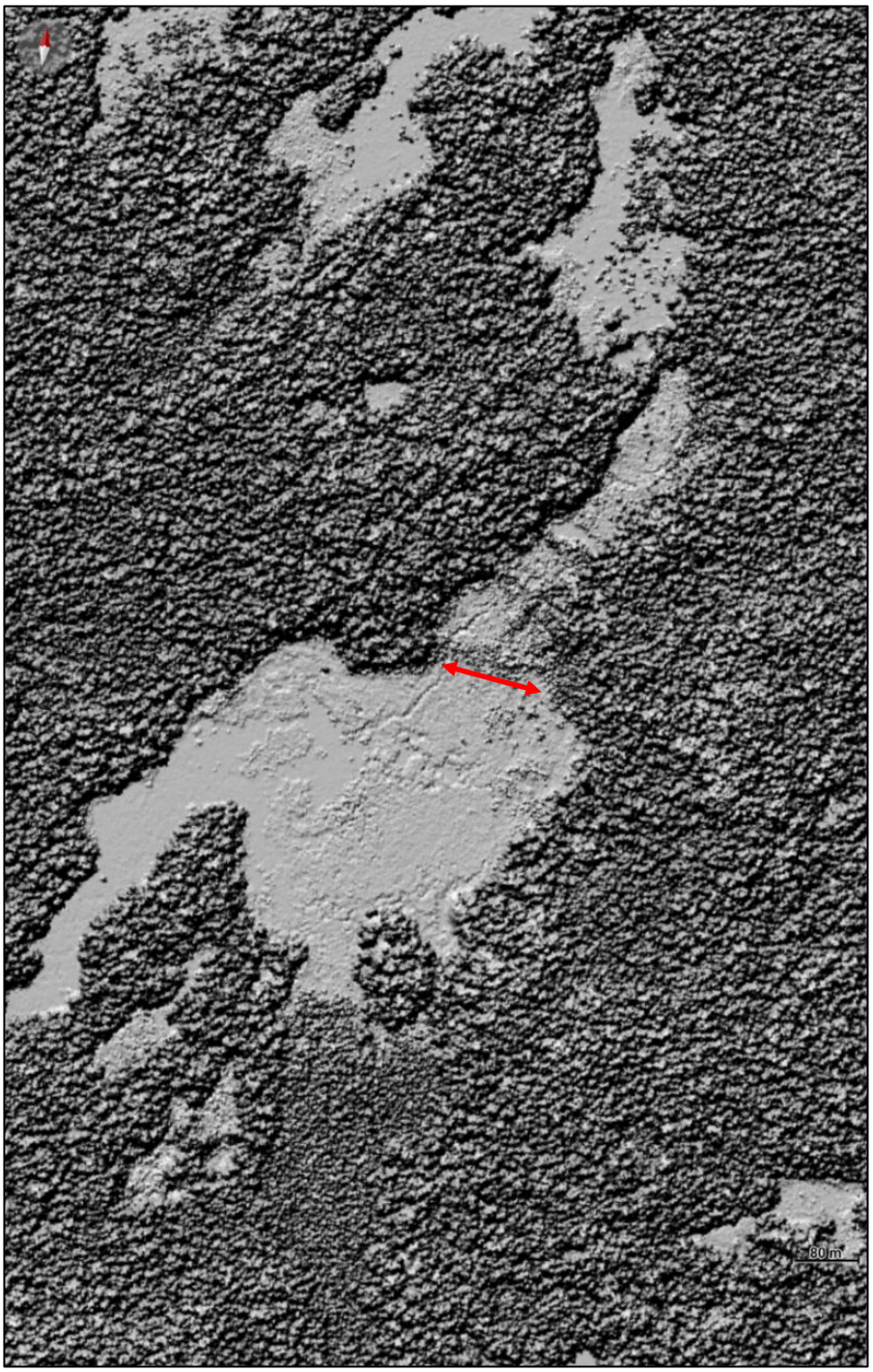


FIGURE 7

PETERBOROUGH COUNTY GIS DIGITAL TERRAIN MODEL, 2 M CONTOURS

PROPOSED CROSSING IN RED

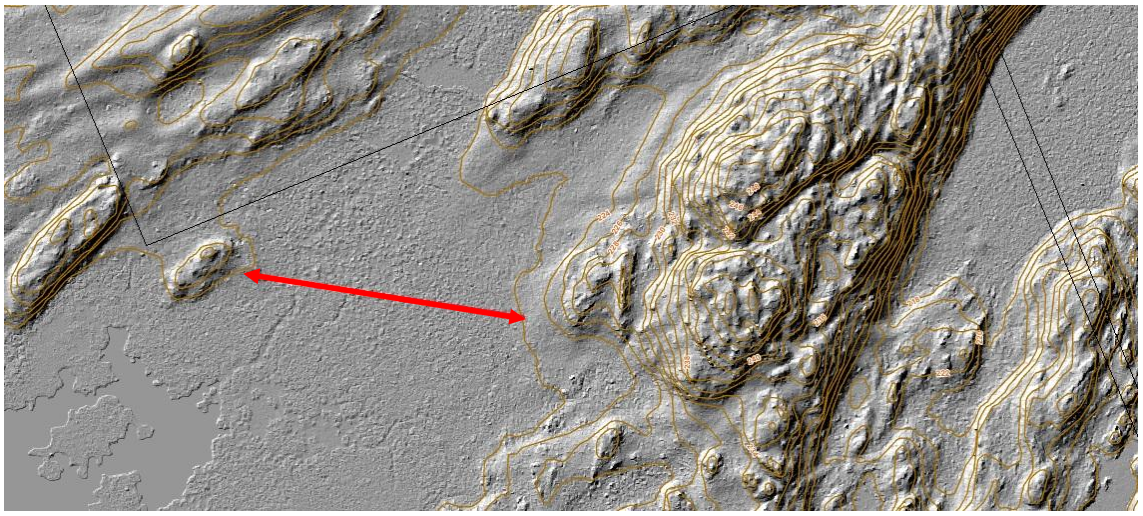
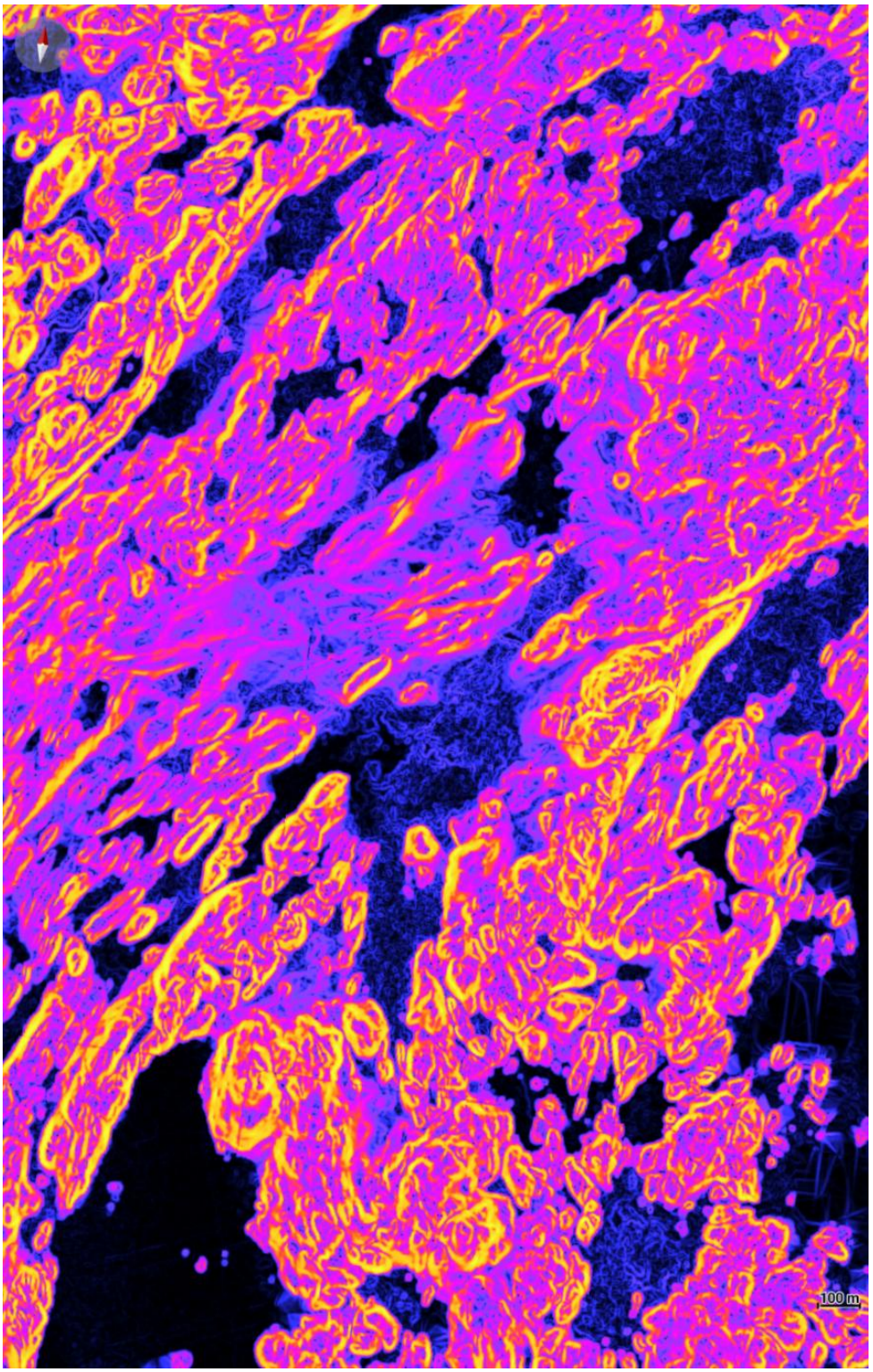


FIGURE 7

COLOUR SLOPE MAP SHOWCASING TERRAIN FEATURES

BOWEN PROPERTY



LOCAL ROLE OF BEAVER DAMS

Inflows to wetland #1 come from a large beaver pond upstream which overtops a beaver dam 2.7 m above the elevation of wetland #1. This steep elevation drop prevents water backing further upstream. Overall water level controls for the five wetlands are attributed to a 1.2 m beaver dam at the outlet of wetland #5. **PHOTOGRAPHS 6** and **7** illustrate conditions at the upper and lower dam sites in the early fall of 2024.

In previous years, the beavers have built a very substantive dam at the outlet, impounding wetland #5 and raising water levels in the other four wetlands. **PHOTOGRAPH 8**, taken in the 1970s, shows much higher water levels in this wetland. Row boats were required to navigate the wetland while trapping and hunting. At other times, during extreme drought conditions and in response to beaver population shifts, considerably less water is stored in the five wetlands.

PHOTOGRAPH 6

BEAVER DAM ABOVE WETLAND #1

PHOTOGRAPH 7

BEAVER DAM AT OUTLET OF WETLAND #5

PHOTOGRAPH 8

WETLAND #5 WITH PROPOSED CROSSING IN BACKGROUND

1970S; HIGH WATER YEARS

LOCAL FLORA AND FAUNA COMMUNITIES ASSOCIATED WITH THE CROSSING WETLAND

Following changes to the CA regulations in 2024, permit applicants are no longer required to undertake ecological studies of wetlands. From our professional knowledge and long-term observations, it can be stated the vegetation at the crossing site are representative of the wetland vegetation communities in Belmont Township. Fauna communities in the five are deemed to be healthy and representative for local habitat conditions. Local flora and fauna communities are more at risk due to climate change than from any disturbance associated with this ATV trail crossing.

WATERSHED CONTEXT

The proposed ATV crossing is in an unnamed tributary of the Otter Creek watershed. Drainage areas upstream of the crossing site, at the outlet of wetland #5, and for the entire Otter Creek were delineated using the Ontario GeoHub watershed tool. Maps showing the boundaries of each drainage were overlain on recent Google Earth Images as illustrated in **FIGURES 8**, **9**, and **10**. The GeoHub watershed tool kit provides key "water catchment" statistics presented in **TABLE 1**. These water resource related metrics were used by Mr. Dobri to assess hydrologic impacts and size the culvert.

The ATV crossing has a footprint 520 m^2 or 0.052 ha, which represents 0.027% of the drainage area above the crossing and 0.017% of the drainage area for all five of the local wetlands. This small footprint can not be deemed to present a significant shift in imperiousness or water storage based upon past experiences modelling several southern Ontario watersheds using the continuous Soil Watershed Assessment Tool (SWAT) model. Small instream structures with profiles akin to local beaver dams would have minor influences at a watershed scale. It should be noted offsetting receiving water features immediately downstream, in wetland #5 which has a large surface area and lots of depressional storage. The drainage area for watershed #5 is about 1.5 times larger than the crossing catchment (**TABLE 2**).

TABLE 2

WATERSHED METRICS FOR STUDY AREA WATERSHEDS ASSOCIATED WITH PROPOSED ATV CROSSING

	CROSSING	OUTLET FIVE WETLANDS	OTTER CREEK
Drainage area (km^2)	1.959	3.013	72.853
Shape factor	6.841	6.542	11.294
Length of main channel (km)	3.661	4.44	28.684
Maximum channel elevation (m)	248.55	248.55	298.71
Minimum channel elevation (m)	219.91	219.45	194.07
Slope of main channel (m/km)	7.82	6.55	3.65
Slope of main channel (%)	0.782	0.655	0.365
Area, lakes and wetlands (km^2)	0.418	0.634	17.45
Area, lakes (km^2)	0.296	0.421	4.841
Area, wetlands (km^2)	0.122	0.212	12.609

FIGURE 9
CATCHMENT WATERSHED ABOVE PROPOSED ATV CROSSING

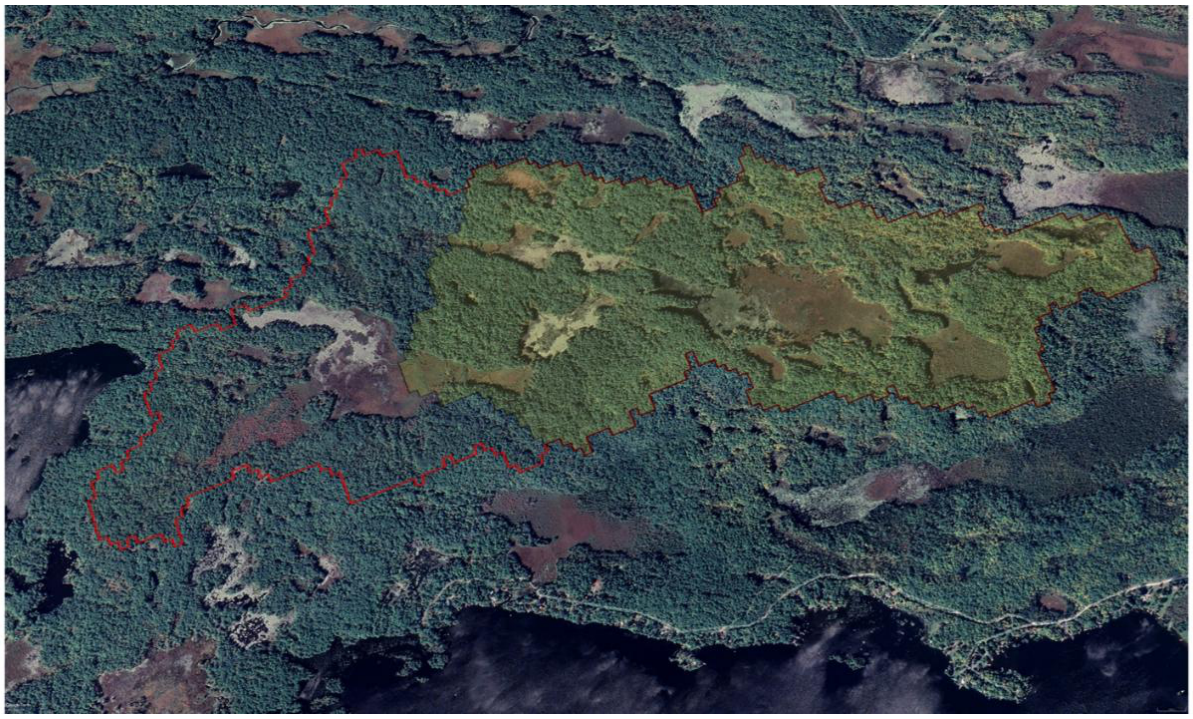


FIGURE 10

WATERSHED CATCHMENTS, OUTLET OF WETLAND #5

INCLUDES CATCHMENT ABOVE PROPOSED CROSSING IN GREEN

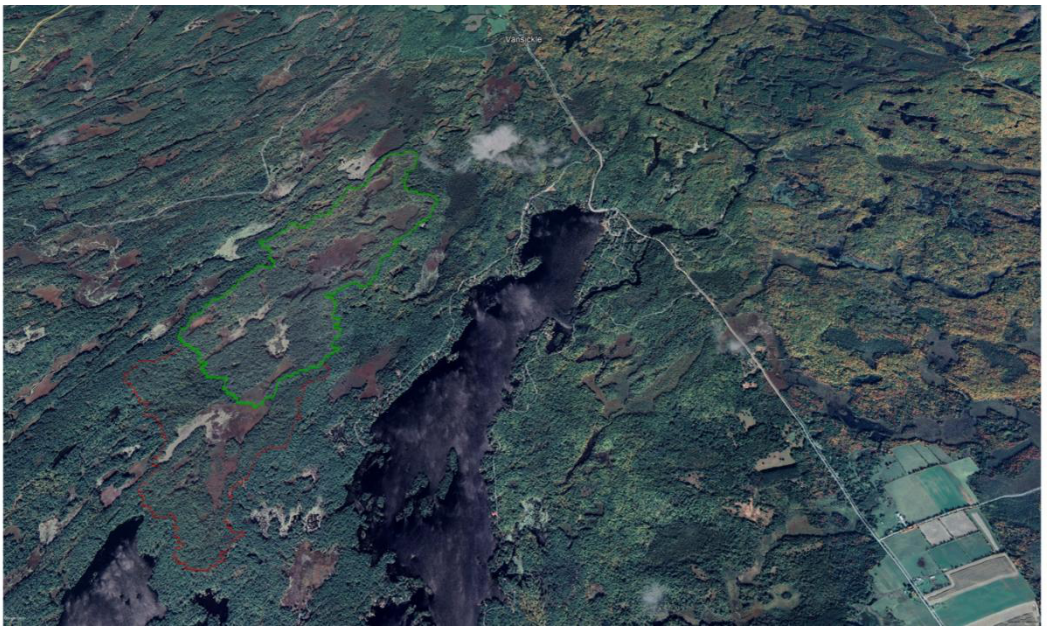
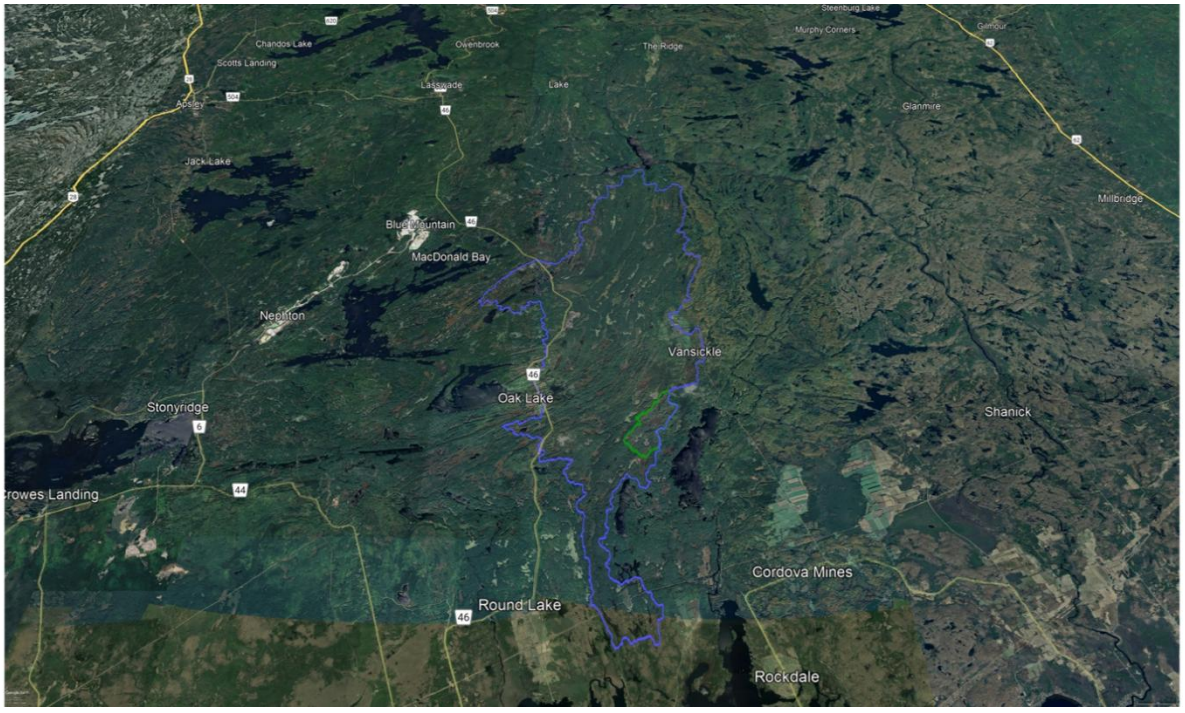


FIGURE 11
OTTER CREEK WATERSHED



RESPONSE TO CVCA RECOMMENDATION TO BUILD A BOARDWALK

The CVCA in their June 19, 2024, email indicate they could approve the construction of an elevated boardwalk across the wetland as a CA regulated, policy-compliant alternative to the proposed ATV trail bed. The utility of a boardwalk was investigated, and it was determined that this would not be acceptable on several grounds.

RATIONALE FOR REJECTING BOARDWALK

- A wooden boardwalk with these dimensions may require a building permit from the Township of Havelock Belmont Methuen HBM. It is anticipated an engineered, stamped design would be required (at considerable expense) to obtain a building permit.
- Cedar building materials for building a boardwalk with sufficient width to safely transport a side-by-side ATV would require four tandem truckloads of cedar logs.
- Four truckloads of logs would require timber harvesting of all the wetlands on our 350 ha property.
- The use of skidders to drag cedar tress out of the swamps and from riparian areas would impact far more wetland features than the footprint of the crossing (520 m^2).
- The wooden board walk structure would have to be evaluated on cement peers as the local beavers would chew the wooden posts.
- Heavy equipment and instream work would be required to build this structure, otherwise the labour cost would be prohibitive.
- Large wooden boardwalks tend to be built along higher use public recreational trails with public or NGO funding.
- To our knowledge, wooden boardwalks have not been required along the ATV and snowmobile associations' trails within the CVCA.

APPENDIX 1

MEMO PREPARED BY DR. WILLIAM BOOTY, RETIRED RESEARCH SCIENTIST

1. There are a number of mounds of glacial till near the proposed crossing that can be used as a source of fill for the crossing. They consist of well-sorted, locally derived coarse sand and gravel (Precambrian metasediments). I personally visited the site with Gary Bowen in July 2024 to inspect the site of the crossing and to select the best sources of local bed materials, which are all outside of the 30-metre buffer zone of the wetland.
2. This material would provide transverse high transmissivity of water through the crossing bed and therefore would prevent significant issues to the watershed flows and locally to the wetlands along with a suitably sized culvert.
3. Any materials that might be eroded from the crossing bed would have minimal downstream implications to the wetlands.
4. A crossing of this size should have a negligible effect from a watershed perspective or locally to the downstream wetlands.

Dr. William G. Booty
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Caistor Centre, Ontario
L0R 1E0

(905) 957–1439
Bill.Booty@hotmail.ca

EDUCATION

1983	McMaster University, Hamilton Doctor of Philosophy in Geology
1977	McMaster University, Hamilton Master of Science in Geology
1975	University of Waterloo Hons. Bachelor of Science Earth Sciences

EMPLOYMENT HISTORY

2014–2016	Senior Water Quality Modeler Baird and Associates
2009–2014	Section Head, Integrated Modelling Section Watershed Hydrology and Ecology Research Division Water Science and Technology Directorate Environment Canada
1988–2009	Research Scientist National Water Research Institute Environment Canada
1983–1988	Research Assistant Professor Dept. of Civil and Environmental Engineering Clarkson University Potsdam, NY, USA

PROFESSIONAL EXPERIENCE

Dr. Booty led a team of scientists at Environment Canada for 25 years in the development of a wide range of watershed and lake models within a decision support system framework, with specific focus on water quality issues. These range from examining the impacts of pulp and paper, mining, oil and gas, toxic chemicals, municipal, and agricultural effluents, as well as atmospheric deposition and climate change impacts on stream and lake water quality across Canada and around the world.

APPENDIX 2
MEMO PREPARED BY MR. BRUNO DOBRI, P. ENG.
DATED DECEMBER 16, 2024

WETLAND CROSSING REPLACEMENT ATV CROSSING
LOT 29, CONCESSION 3, BELMONT TOWNSHIP

Mr. Gary Bowen:

You provided me with a substantial amount of information on your property and adjacent land. The information included photos and available mapping of the area and a detailed description of the work you intend to perform with a sketch of the plan. In summary, you are using an existing ATV trail through the wetland to access your property. The existing trail includes an ATV crossing over your neighbour's property. You propose to construct a new crossing on your property (downstream of the existing crossing) and stop using the existing trail crossing.

You made an application to the Crowe Valley Conservation Authority (CVCA). Your application included the supporting documents that you provided to me. The information included your intended construction approach and an elevation sketch of the proposed crossing (both attached). The 600 mm CSP would have a minimum 600 mm (2') of cover. The crossing across the wetland would be approximately 130 m long. CVCA denied the application and requested sizing for the culvert and confirmation that the hydrological function of the wetland will not be impacted.

SITE SUMMARY

Upstream area	193 ha
Travel distance **L**	3,546 m
Travel slope **S**	0.80%
Runoff coefficient **C**	0.05 (wetlands/lakes)

CALCULATE THE TIME OF CONCENTRATION

$$\mathbf{Tc} = 3.26(1.1-C)\frac{L^{0.5}}{S^{½}}$$

$$= 219.4 \text{ minutes}$$

MTO IDF DATA

Where **I** (mm/hr) = $\mathbf{A} \times (\frac{t}{60})^{\mathbf{B}}$

RETURN PERIOD	REGRESSION CONSTANTS A	B
2-year	21.4	-0.699
5-year	28.3	-0.699
10-year	32.9	-0.699
25-year	38.7	-0.699
50-year	43	-0.699
100-year	47.2	-0.699

CALCULATE THE PEAK FLOW AT THE PROPOSED CROSSING FOR VARIOUS STORM EVENTS

t (min)=		219.4	**EVENT**	2 YR	5 YR	10 YR	25 YR	50-YR	100-YR
C	=	0.05	**I (mm/hr)**	8.65	11.43	13.29	15.64	17.37	19.07
A	=	193 ha	**Q (cm)**	0.234	0.309	0.359	0.422	0.469	0.515

The selected design flow through the culvert is contingent on the intended use of the crossing. For example, a culvert under a driveway may only require conveyance of the peak flow during the five-year storm event, whereas a culvert under a roadway may require conveyance of the peak flow during the 25-year storm event. For the ATV crossing, a culvert conveying the peak flow during the five-year storm even would be sufficient, since the use is limited.

The estimated peak flow through the proposed culverttt is 0.515 cm during the 100-year storm event. Install a 600 mm diameter CSP culvert at the proposed ATV trail crossing location. Using the MTO Design Chart 2.32: Inlet Control: Circular CSP and SPCSP, with 600 mm earth cover over the culvert, the flow through the culvert is 0.6 cm. The culvert will convey the calculated peak flow during the 100-year storm event, which exceeds normal design practice.

The proposed crossing will create a berm with the top elevation at approximately 222 m (masl) and a bottom elevation of approximately 220.5 m. The berm will be a minimum 1.2 m high and have a maximum top width of 4 m. The above is illustrated in the **ATTACHMENTS**.

Based on my analysis, I am of the opinion that relocating the existing ATV trail further south through the wetland and on your property will not negatively impact the existing wetland.

PREPARED BY:

Bruno Dobri, P. Eng.
Dobri Engineering Ltd.
205 Peter Street
PO Box 441
Port Hope, Ontario
L1A 3Z3

ATTACHMENTS

1. MTO IDF Curve Lookup
2. MTO Drainage Management Manual – Design Chart 1.07 Runoff Coefficients
3. MTO Drainage Management Manual – Design Chart 2.32: Inlet Control: Circular CSP

OTHER INCLUDED MATERIALS:

See prior pages.

FIGURE	1	Site map prepared by Dobri Engineering Ltd.
	2	Lot 29 Wetland; border and scale added by Dobri Engineering Ltd.
	3	Proposed ATV crossing site
	4	Crossing design diagram per sketch by John Bowen
	5	Marsh areas (Wetlands Ontario GeoHub)
	6	Digital Terrain Model of adjacent wetlands
	7	Digital Terrain Model, 2 m contours
	8	Colour slope map
	9	Catchment watershed above proposed ATV crossing
	10	Watershed catchments, outlet of wetland #5
	11	Otter Creek watershed
PHOTOGRAPH	1	Drone photo of wetland #5
	2	Creek at proposed crossing
	3	Creek channel in summer 2024
	4	Vegetation at proposed crossing site
	5	View from top of crossing beaver dam
	6	Beaver dam above wetland #1
	7	Beaver dam at outlet of wetland #5
	8	1970s photo of wetland #5
APPENDIX	1	Memo prepared by Dr. William Booty, retired research scientist
	2	Memo prepared by Mr. Bruno Dobri, P. Eng.

ATTACHMENT 1

MTO IDF CURVE LOOKUP

Ontario IDF CURVE LOOKUP

Active coordinate

44° 34' 45" N, 77° 50' 44" W (44.579167,-77.845833)

Retrieved: Fri, 06 Sep 2024 14:22:39 GMT

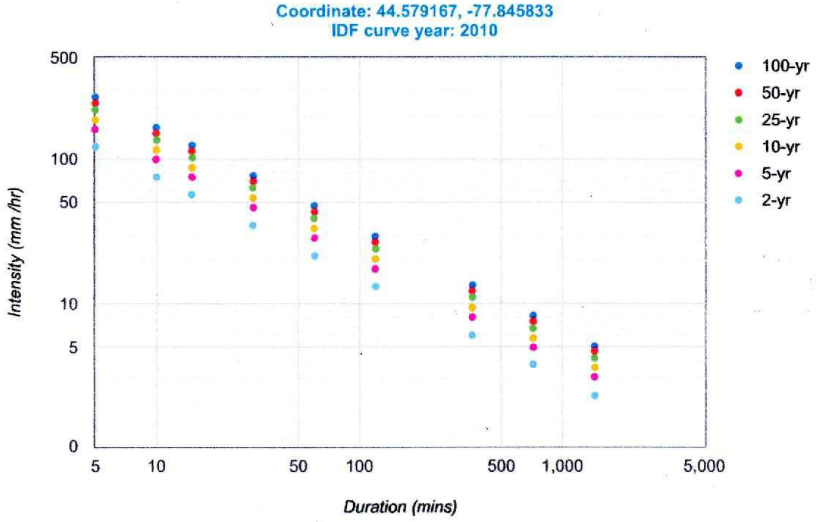
Location summary

These are the locations in the selection.

IDF Curve: 44° 34' 45" N, 77° 50' 44" W (44.579167,-77.845833)

Results

An IDF curve was found.



ATTACHMENT 1

MTO IDF CURVE LOOKUP

Coefficient summary

IDF Curve: 44° 34' 45" N, 77° 50' 44" W (44.579167,-77.845833)

Retrieved: Fri, 06 Sep 2024 14:22:39 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	21.4	28.3	32.9	38.7	43.0	47.2
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	121.6	74.9	56.4	34.7	21.4	13.2	6.1	3.8	2.3
5-yr	160.7	99.0	74.6	45.9	28.3	17.4	8.1	5.0	3.1
10-yr	186.9	115.1	86.7	53.4	32.9	20.3	9.4	5.8	3.6
25-yr	219.8	135.4	102.0	62.8	38.7	23.8	11.1	6.8	4.2
50-yr	244.2	150.5	113.3	69.8	43.0	26.5	12.3	7.6	4.7
100-yr	268.1	165.1	124.4	76.6	47.2	29.1	13.5	8.3	5.1

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	10.1	12.5	14.1	17.4	21.4	26.4	36.7	45.2	55.7
5-yr	13.4	16.5	18.6	23.0	28.3	34.9	48.5	59.8	73.7
10-yr	15.6	19.2	21.7	26.7	32.9	40.5	56.4	69.5	85.6
25-yr	18.3	22.6	25.5	31.4	38.7	47.7	66.4	81.8	100.7
50-yr	20.4	25.1	28.3	34.9	43.0	53.0	73.7	90.8	111.9
100-yr	22.3	27.5	31.1	38.3	47.2	58.2	80.9	99.7	122.9

Terms of Use

ATTACHMENT 3
MTO DRAINAGE MANAGEMENT MANUAL
DESIGN CHART 1.07 RUNOFF COEFFICIENTS

Design Chart 1.07: Runoff Coefficients (Continued)

- Rural

Land Use & Topography[2]	Soil Texture		
	Open Sand Loam	Loam or Silt Loam	Clay Loam or Clay
CULTIVATED			
Flat 0 - 5% Slopes	0.22	0.35	0.55
Rolling 5 - 10% Slopes	0.30	0.45	0.60
Hilly 10- 30% Slopes	0.40	0.65	0.70
PASTURE			
Flat 0 - 5% Slopes	0.10	0.28	0.40
Rolling 5 - 10% Slopes	0.15	0.35	0.45
Hilly 10- 30% Slopes	0.22	0.40	0.55
WOODLAND OR CUTOVER			
Flat 0 - 5% Slopes	0.08	0.25	0.35
Rolling 5 - 10% Slopes	0.12	0.30	0.42
Hilly 10- 30% Slopes	0.18	0.35	0.52
BARE ROCK	COVERAGE[3]		
	30%	50%	70%
Flat 0 - 5% Slopes	0.40	0.55	0.75
Rolling 5 - 10% Slopes	0.50	0.65	0.80
Hilly 10- 30% Slopes	0.55	0.70	0.85
LAKES AND WETLANDS	0.05		

[2] Terrain Slopes

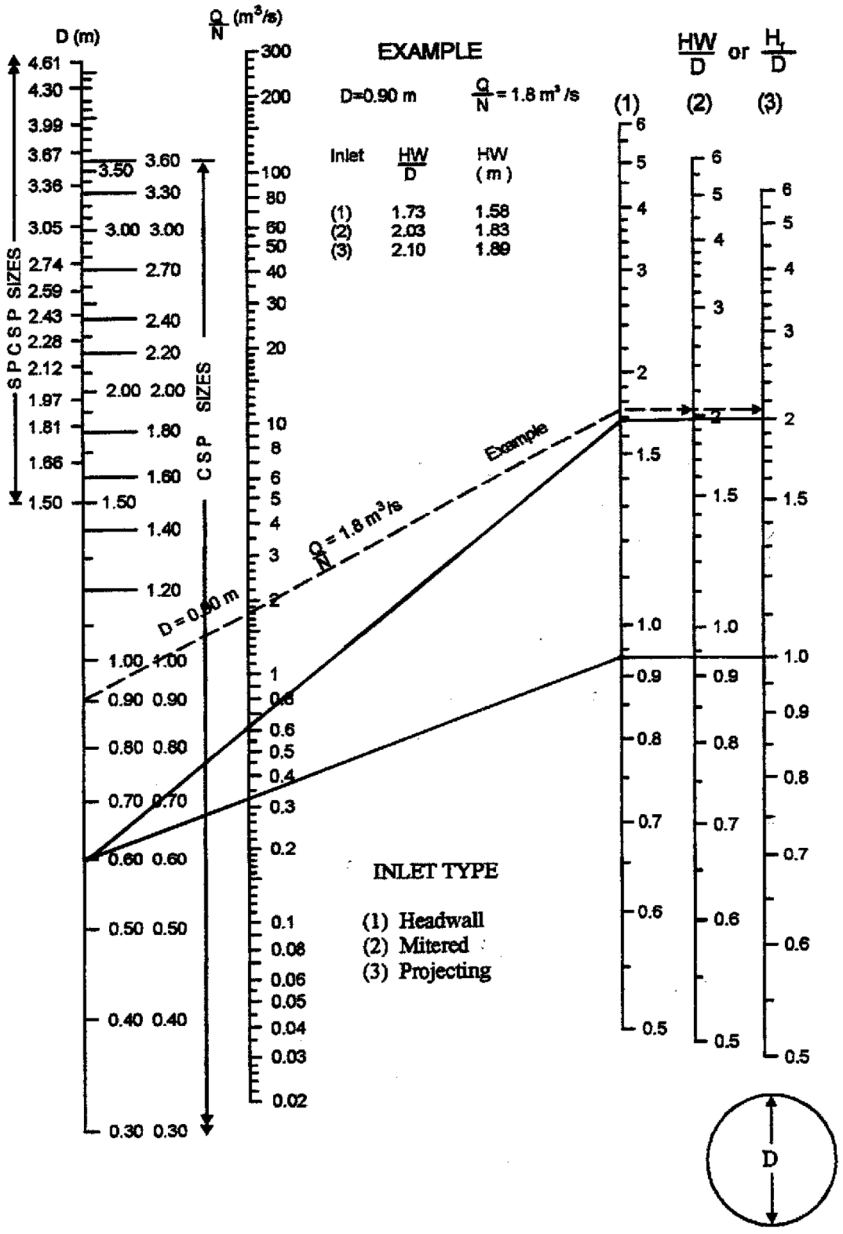
[3] Interpolate for other values of % imperviousness

Sources: American Society of Civil Engineers - ASCE (1960)
U.S. Department of Agriculture (1972)

ATTACHMENT 4

DESIGN CHART 2.32: INLET CONTROL: CIRCULAR CSP

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts



Source: Herr (1977)

DEC. 16/24