APPENDIX E
TECHNICAL REPORTS – TERRESTRIAL

APPENDIX E.1 TOUQUOY GOLD MINE – STUDY AREA EXTENSION (SQUARE LAKE): WETLAND AND WATERCOURSE DELINEATION

January 17, 2020

Melissa Nicholson
Atlantic Mining NS
6749 Moose River Rd,
Middle Musquodoboit,
Nova Scotia, B0N 1X0

Re: Touquoy Gold Mine – Study Area Extension (Square Lake): Wetland and Watercourse Delineation

1 INTRODUCTION

Atlantic Mining Nova Scotia (AMNS) retained McCallum Environmental Ltd. (MEL) to conduct a wetland and watercourse assessment within an extension of the current Touquoy Mine Site Study Area located in Middle Musquodoboit, NS.

The Study Area extension is bound between Square Lake to the north and the original study area to the south. The Study Area extension exists within PIDs 40747818 and 00457699 and is approximately 10 ha in size. The Square Lake Study Area extension is provided in Figure 1 (Appendix A).

MEL conducted biophysical assessments to determine the locations of potential wetlands and watercourses within the Study Area. The assessment included an evaluation of desktop resources and a field program on November 7th, 2019.
The purpose of this report is to provide wetland and watercourse locations and characterizations to support continued future development of the Touquoy Mine.

2 METHODOLOGY

2.1 Desktop Review

A background information review of wetlands and watercourses was completed using the Nova Scotia Topographic Watercourse (NSTD) and the Nova Scotia Environment (NSE) Wetlands database. In addition, the NSE "Wetlands of Special Significance" (WSS) database was also reviewed.

2.2 Field Assessment

The field assessment was completed on November 7th, 2019 by MEL wetland delineator Ryan Gardiner. Meandering transects were completed within the Study Area extension to confirm the potential presence of wetlands and watercourses. This report adopts the terms defined by NSE under Section 105 of the *Environment Act*.

> Wetlands are:
> *Land referred to as a marsh, swamp, fen, or bog that either periodically or permanently has water table at, near, or above the land surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation, and biological activities adapted to wet conditions.*

Watercourses are:
The bed and shore of every river, stream, lake, creek, pond, spring, lagoon or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and all groundwater.

Wetland boundaries were determined as described by the US Army Corps of Engineers, adapted for the Northcentral and Northeast Regions of the US (US Army Corp of Engineers, 2012) based on topography, soil and hydrology properties, and vegetation. All watercourses encountered during the assessment were also identified.

Wetland Data Determination forms were completed within each wetland identified and wetland boundaries and watercourse routes were recorded on a Geneq SX Blue II receiver and SX Blue pad. The Geneq SX Blue II receiver is capable of sub 1 m accuracy.

3 RESULTS

3.1 Desktop Review

According to the database searches a single wetland was identified in the northern extent of Study Area extension along the shoreline of Square Lake. This wetland was verified (WL55) during the field surveys and is described in further detail below. No mapped watercourses are present in the Study Area extension.

Similar to the original Study Area, the desktop review process determined that the Study Area extension is located in an Endangered Mainland Moose Concentration Area. The desktop review also confirmed that the Study Area extension does not exist within or contain the following:

- Ramsar site, Provincial Wildlife Management Area (Crown and Provincial lands only), Provincial Park, Nature Reserve, Wilderness Area or lands owned or legally protected by non-government charitable conservation land trusts;
- Wetlands in designated protected water areas as described within Section 106 of the Environment Act; or,
- A designated wetland of special significance (WSS).

The Study Area extension is situated in upper portions of the Fish River – Square Lake Tertiary Watershed (1EL-5-M). Surface water within this watershed drains south towards Scraggy Lake) located approximately 3 km south of the Study Area extension.

3.2 Field Results

3.2.1 Wetlands

Three wetlands were identified within the Study Area extension (Figure 2, Appendix A). The wetlands were identified as WLs 53 to 55. Confirmation of the presence of hydrophytic vegetation, wetland hydrology and hydric soils was established by the completion of a single data point within each wetland and adjacent upland habitat. Wetland Determination Data Forms are provided in Appendix B.

Wetland 53

Wetland 53 exists as a lentic fen 821 m^2 in size. The wetland exists in a basin formation and intercepts surface water run-off from surrounding low gradient upland habitat and bidirectional flow from Square Lake.

Hydrological conditions encountered at the data point location within the wetland are indicated by intermittent surface water to a depth of 3 cm, a high-water table and saturation at surface.

A survey for hydrophytic vegetation was completed in the wetland. The vegetative community is dominated by Black Spruce (*Picea mariana*), Balsam Fir (*Abies balsamea*) and Tamarack (*Larix laricina*) in the sparse tree and shrub layers. Leatherleaf (*Chamaedaphne calyculata*) and Reed Canary Grass (*Phalaris arundinacea*) were observed to dominate the herbaceous layer.

A soil pit was completed within the wetland to test for hydric soil conditions. Fibric organic soil to a depth of 50+ cm with no restrictive layer was observed. Hydric soil is present as indicated by a Histosol (Indicator A1).

Wetland 54

Wetland 54 exists as an isolated treed swamp 2,058 m^2 in size. The wetland exists in a basin formation and intercepts surface water run-off from surrounding low gradient upland habitat. Wetland 54 is not hydrologically connected to the nearby Square Lake.

Hydrological conditions encountered at the data point location within the wetland are indicated by a high-water table and saturation at surface.

A survey for hydrophytic vegetation was completed in the wetland. The vegetative community is dominated by Balsam Fir in the tree and shrub layers. Sheep Laurel (*Kalmia angustifolia*) and Cinnamon Fern (*Osmunda cinnamomea*) were observed to dominate the herbaceous layer.

A soil pit was completed within the wetland to test for hydric soil conditions. Fibric organic soil to a depth of 20 cm was observed above a restrictive layer of rock. Hydric soil is present as indicated by a Histic Epipedon (Indicator A2).

Wetland 55

Wetland 55 exists as a treed swamp and lentic fen complex that extends beyond the Study Area extension boundary to the north. Within the Study Area extension, 7,069 m^2 of Wetland 55 was delineated. The wetland exists in a basin formation with the treed swamp portion intercepting surface water run-off from surrounding low gradient upland habitat and the fen portion receiving bidirectional flow from Square Lake.

Hydrological conditions encountered at the data point location within the treed swamp portion of the wetland are indicated by a high-water table and saturation at surface.

A survey for hydrophytic vegetation was completed in the wetland. The vegetative community is dominated by Black Spruce and Balsam Fir in the tree and shrub layers. Three-seeded Sedge (*Carex trisperma*) and Cinnamon Fern were observed to dominate the herbaceous layer.

A soil pit was completed within the wetland to test for hydric soil conditions. Fibric organic soil to a depth of 20 cm above a restrictive layer of rock. Hydric soil is present as indicated by a Histic Epipedon (Indicator A2).

General observations within the fen portion of the wetlands indicate that the hydrological, soil and vegetation conditions are similar to those described in Wetland 53. A summary of the data point results and wetland characteristics for each wetland are provided in Table 1 and Table 2.

Table 1: Wetland Determination Data Point Results

Data Point ID	Hydrophytic Vegetation Present:	Hydric Soil Indicator	Indicators of Wetland Hydrology	Positive Test for Wetland Habitat
WL 53	Yes – 2.16 PI Value	A1 – Histosol	Surface water, Saturated at surface, High water table,	Yes
WL 54	Yes – 2.97 PI value	A2 – Hist Epipedon	Surface water, High water table	Yes
UP 53/54	No - 3.24 PI Value	N/A	None	No
WL 55	Yes – 2.4 PI Value	A2 – Hist Epipedon	Surface water, High water table	Yes
UP 55	No – 3.2 PI Value	N/A	None	No

*A Prevalence Index (PI) Value equal to or less than 3 indicates hydrophytic vegetation.

Table 2: Wetland Characteristic Summary

WL ID	Size (m^2)	Type	Landform	Landscape Position	Water Flow Path
WL 53	821	Fen	Basin	Lentic	Bidirectional – nontidal
WL 54	2058	Treed Swamp	Basin	Terrene	Isolated
WL 55	7069	Fen/Swamp Complex	Sloped/Basin	Lentic	Bidirectional - nontidal

The locations of the wetlands are provided in Figure 1 (Appendix A). Representative photos are provided in Appendix C.

3.2.2 Watercourses

The field survey confirmed that no watercourses are present within the Study Area extension.

4 SUMMARY

The identified wetlands present characteristics typical of fen and treed swamp wetlands in Nova Scotia and the region generally. The three wetlands encompass a total combined area of 9,948 m^2 within the Study Area extension. Although the detailed functional assessment process has not been completed at this time, there are no conditions or wetland characteristics observed which trigger the wetland to exist as a Wetland of Special Significance.

4.1 Recommendations

Should alteration of the identified wetlands be required, a wetland alteration application should be compiled and submitted to NSE. To fulfill the requirements of a wetland alteration application additional field surveys are required between June 1st and September 30th to complete wetland functions assessment and species at risk surveys.

If you have any questions, please don’t hesitate to contact the undersigned with any questions you might have.

Sincerely,

Ryan Gardiner,
Intermediate Environmental Scientist
McCallum Environmental Ltd.

Andy Walter
Senior Project Manager
McCallum Environmental Ltd.

APPENDIX A: Figures

Prepared For:

Atlantic Gold

Figure 1

Touquoy Gold Mine

Wetland Delineation Results
Square Lake Study Area Extension

- Field Delineated Watercourse
- NSTDB Mapped Watercourse
- Wetland
- Square Lake Study Area Extension
- Study Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 50 100 200 m

1:4,000

Scale when printed @ 11" x 17"

Drawn By: R. Gardiner

Date: 2020-01-03

McCallum Environmental Ltd.

Document Name: 200103_TQ_Wetland_Delineation_Results

McCallum Environmental Ltd.

APPENDIX B: Wetland Determination Data Forms

WETLAND DETERMINATION DATA FORM – NOVA SCOTIA

Project/Site: TQ Municipality/County: HRM Sampling Date: 7-Nov-19

Applicant/Owner: AMNC Sampling Point: WL 53

Investigator(s): R. Gardner Affiliation: McCallum Environmental

Landform (hillslope, terrace, etc.): ______ Local relief (concave, convex, none): Concave

Slope (%): ______ Lat: 505491 Long: 4982163 Datum: NAD 83

Soil Map Unit Name/Type: ______ Wetland Type: Fen

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ✗, Soil ✗, or Hydrology ✗ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ✗, Soil ✗, or Hydrology ✗ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 10m²)			
1. Picea mariana	10	✓	FACW
2. Larix laricina	5	✓	FAC
3.			
4.			
5.			
	15 = Total Cover		
Sapling/Shrub Stratum (Plot size: 5m²)			
1. Larix laricina	10	✓	FAC
2. Picea mariana	5	✓	FACW
3.			
4.			
5.			
	15 = Total Cover		
Herb Stratum (Plot size: 1m²)			
1. Phalaris arundinacea	25	✓	FACW
2. Rhododendron groenlandicum	8		FACW+
3. Kalmia angustifolia	6		FAC
4. Rosa nitida	2		OBL
5. Chamaedaphne calyculata	35	✓	OBL
6.			
7.			
8.			
9.			
10.			
	76 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	____ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	37	x 1 = 37
FACW species	48	x 2 = 96
FAC species	21	x 3 = 63
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	106 (A)	229 (B)

Prevalence Index = B/A = 2.16

Hydrophytic Vegetation Indicators:

- ___ Rapid Test for Hydrophytic Vegetation
- ✓ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

7-Nov-19 TQ Sampling Point: WL53

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
50.0 cm								Organic

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ✓ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ Depleted Dark Surface (F7)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Redox Depressions (F8)
- __ Red Parent Material (TF2)

Indicators for Problematic Hydric Soils[3]:

- __ Sandy Gleyed Matrix (S4)
- __ Coast Prairie Redox (A16)
- __ 5 cm Mucky Peat or Peat (S3)
- __ Iron-Manganese Masses (F12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____

Depth (inches): ____

Hydric Soil Present? Yes ✓ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✓ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No ____ Depth (inches): 3 cm

Water Table Present? Yes ✓ No ____ Depth (inches): 0 cm

Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 0 cm

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – NOVA SCOTIA

Project/Site: TA Municipality/County: HRM Sampling Date: 7-Nov-19

Applicant/Owner: AMNS Sampling Point: Wet 54

Investigator(s): R. Gardner Affiliation: McCallum Environmental

Landform (hillslope, terrace, etc.): ______ Local relief (concave, convex, none): Concave

Slope (%): ______ Lat: 505847 Long: 4982190 Datum: NAD 83

Soil Map Unit Name/Type: ______ Wetland Type: Treed swamp

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✗, Soil ✗, or Hydrology ✗ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ✗, Soil ✗, or Hydrology ✗ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___	
Hydric Soil Present? Yes ✓ No ___	If yes, optional Wetland Site ID: ______	
Wetland Hydrology Present? Yes ✓ No ___		

Remarks: (Explain alternative procedures here or in a separate report.)

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 10 m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus strobus	10		FAC
2. Abies balsamea	65	✓	FAC
3.			
4.			
5.			
	75 = Total Cover		
Sapling/Shrub Stratum (Plot size: 5m²)			
1. Abies balsamea	25	✓	FAC
2. Picea mariana	5		FACW
3.			
4.			
5.			
	30 = Total Cover		
Herb Stratum (Plot size: 1m²)			
1. Osmunda cinnamomea	30	✓	FAC
2. Kalmia angustifolia	15	✓	FAC
3. Coptis trifolia	5		FAC
4.			
5.			
6.			
7.			
8.			
9. Sphagnum ground cover			
10.			
	50 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	___ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ___	x 1 = ___
FACW species 5	x 2 = 10
FAC species 150	x 3 = 450
FACU species ___	x 4 = ___
UPL species ___	x 5 = ___
Column Totals: 155 (A)	460 (B)

Prevalence Index = B/A = 2.97%

Hydrophytic Vegetation Indicators:

- ___ Rapid Test for Hydrophytic Vegetation
- ✓ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: Wet 54

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
20-0 cm								Organic

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- __ Histosol (A1)
- ✓ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ Depleted Dark Surface (F7)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Redox Depressions (F8)
- __ Red Parent Material (TF2)

Indicators for Problematic Hydric Soils[3]:

- __ Sandy Gleyed Matrix (S4)
- __ Coast Prairie Redox (A16)
- __ 5 cm Mucky Peat or Peat (S3)
- __ Iron-Manganese Masses (F12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Rock

Depth (inches): 20 cm

Hydric Soil Present? Yes ✓ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ✓	Depth (inches): ____
Water Table Present?	Yes ✓	No ____	Depth (inches): 20cm
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 0 cm

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – NOVA SCOTIA

Project/Site: TQ Municipality/County: HRM Sampling Date: 7-Nov-19

Applicant/Owner: AMNS Sampling Point: Up 53/54

Investigator(s): R. Gardiner Affiliation: McCallum Environmental

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): ______

Slope (%): ______ Lat: 50582156 Long: 4982156 Datum: NAD 83

Soil Map Unit Name/Type: ______ Wetland Type: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✗, Soil ✗, or Hydrology ✗ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ✗, Soil ✗, or Hydrology ✗ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland? Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓	
Wetland Hydrology Present?	Yes ___ No ✓	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 10 m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies balsamea	30	✓	FAC
2. Acer rubrum	10	✓	FAC
3.			
4.			
5.			
	40	= Total Cover	
Sapling/Shrub Stratum (Plot size: 5 m²)			
1. Abies balsamea	40	✓	FAC
2. Picea glauca	20	✓	FAC
3.			
4.			
5.			
	60	= Total Cover	
Herb Stratum (Plot size: 1 m²)			
1. Pteridium aquilinum	35	✓	FACU
2. Cornus canadensis	8		FAC
3. Trientalis borealis	2		FAC
4. Kalmia angustifolia	3		FAC
5.			
6.			
7.			
8.			
9.			
10.			
	48	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species	113	x 3 = 339
FACU species	35	x 4 = 140
UPL species		x 5 =
Column Totals:	148 (A)	479 (B)

Prevalence Index = B/A = 3.24

Hydrophytic Vegetation Indicators:

- ___ Rapid Test for Hydrophytic Vegetation
- ✓ Dominance Test is >50%
- ✗ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No ✓

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

7-Nov-19 TQ Sampling Point: Up 53

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
3-0 cm								Organic

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Depleted Dark Surface (F7)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Polyvalue Below Surface (S8)
- ___ Thin Dark Surface (S9)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Redox Depressions (F8)
- ___ Red Parent Material (TF2)

Indicators for Problematic Hydric Soils[3]:

- ___ Sandy Gleyed Matrix (S4)
- ___ Coast Prairie Redox (A16)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Rock

Depth (inches): 3 cm

Hydric Soil Present? Yes ___ No ✓

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___

Water Table Present? Yes ___ No ✓ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – NOVA SCOTIA

Project/Site: TQ Municipality/County: HRM Sampling Date: 7-Nov-19

Applicant/Owner: AMNS Sampling Point: Wet 55

Investigator(s): R. Cardiar Affiliation: McCallum Environmental

Landform (hillslope, terrace, etc.): s Local relief (concave, convex, none): concave

Slope (%): ______ Lat: 505267 Long: 4982560 Datum: NAD 83

Soil Map Unit Name/Type: ______ Wetland Type: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✗, Soil –, or Hydrology ✗ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation –, Soil –, or Hydrology – naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ___ No ___	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 10m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea mariana	30	✓	FACW
2. Abies balsamea	10	✓	FAC
3.			
4.			
5.			
	40 = Total Cover		

Sapling/Shrub Stratum (Plot size: 5m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Abies balsamea	30	✓	FAC
2. Picea mariana	10	✓	FACW
3.			
4.			
5.			
	40 = Total Cover		

Herb Stratum (Plot size: 1m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Osmunda cinnamomea	40	✓	FAC
2. Carex trisperma	25	✓	OBL
3. Kalmia angustifolia	5		FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	70 = Total Cover		

Woody Vine Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
	___ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 % (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	25	x 1 = 25
FACW species	40	x 2 = 80
FAC species	85	x 3 = 255
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	150 (A)	360 (B)

Prevalence Index = B/A = 2.4

Hydrophytic Vegetation Indicators:

- ___ Rapid Test for Hydrophytic Vegetation
- ✓ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Adapted from U.S. Army Corps of Engineers form for Northeast-North Central Supplement for use in Nova Scotia (2009)

SOIL

Sampling Point: wet 55

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
20 - 0								Organic

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- __ Histosol (A1)
- ✓ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ Depleted Dark Surface (F7)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Redox Depressions (F8)
- __ Red Parent Material (TF2)

Indicators for Problematic Hydric Soils[3]:

- __ Sandy Gleyed Matrix (S4)
- __ Coast Prairie Redox (A16)
- __ 5 cm Mucky Peat or Peat (S3)
- __ Iron-Manganese Masses (F12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Rock

Depth (inches): 20 cm

Hydric Soil Present? Yes ✓ No ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No ✓ Depth (inches): ____

Water Table Present? Yes ✓ No ____ Depth (inches): -10 cm

Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 0 cm

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – NOVA SCOTIA

Project/Site: TQ Municipality/County: HRM Sampling Date: 7-Nov-19
Applicant/Owner: AMNS Sampling Point: Up 55
Investigator(s): R. Gardiner Affiliation: MEC
Landform (hillslope, terrace, etc.): ______ Local relief (concave, convex, none): ______
Slope (%): ______ Lat: 505296 Long: 4982553 Datum: ______
Soil Map Unit Name/Type: ______ Wetland Type: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)
Are Vegetation X, Soil X, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation X, Soil X, or Hydrology X naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓

Is the Sampled Area within a Wetland? Yes ______ No ✓
If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 10 m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Betula papyrifera	15	✓	FACU
2. Picea glauca	5	✓	FAC
3.			
4.			
5.			
= Total Cover	20		

Sapling/Shrub Stratum (Plot size: 5 m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Betula papyrifera	15	✓	FACU
2. Abies balsamea	25	✓	FAC
3. Picea glauca	5		FAC
4.			
5.			
= Total Cover	45		

Herb Stratum (Plot size: 1 m²)	Absolute % Cover	Dominant Species?	Indicator Status
1. Kalmia angustifolia	55	✓	FAC
2. Cornus canadensis	25	✓	FAC
3. Gaultheria hispidula	5		FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	85		

Woody Vine Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
= Total Cover			

Remarks: (Include photo numbers here or on a separate sheet.)

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species	120	x 3 = 360
FACU species	30	x 4 = 120
UPL species		x 5 =
Column Totals:	150 (A)	480 (B)

Prevalence Index = B/A = 3.2

Hydrophytic Vegetation Indicators:

- __ Rapid Test for Hydrophytic Vegetation
- ✓ Dominance Test is >50%
- X Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ✓

Adapted from U.S. Army Corps of Engineers form for Northeast-North Central Supplement for use in Nova Scotia (2009)

SOIL

7-Nov-19 TQ Sampling Point: UP 55

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
3-0								Organic

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ Depleted Dark Surface (F7)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Redox Depressions (F8)
- __ Red Parent Material (TF2)

Indicators for Problematic Hydric Soils[3]:

- __ Sandy Gleyed Matrix (S4)
- __ Coast Prairie Redox (A16)
- __ 5 cm Mucky Peat or Peat (S3)
- __ Iron-Manganese Masses (F12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Rock

Depth (inches): 3cm

Hydric Soil Present? Yes ____ No ✓

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No ✓ Depth (inches): ____

Water Table Present? Yes ____ No ✓ Depth (inches): ____

Saturation Present? (includes capillary fringe) Yes ____ No ✓ Depth (inches): ____

Wetland Hydrology Present? Yes ____ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

APPENDIX C: Photolog

Appendix C: Photolog

Photo 1: Representative Fen Habitat in WL 53

Photo 2: Representative Fen Habitat in WL 53

Photo 3: Representative Swamp Habitat in WL 54

Photo 4: Representative Swamp Habitat in WL 54

Photo 5: Representative Swamp Habitat in WL 55

Photo 6: Representative Fen Habitat in WL 55

APPENDIX E.2
TOUQUOY MINE GOLD PROJECT, 2020 ANNUAL WETLAND COMPENSATION REPORT

March 31, 2021

Melissa Nicholson
Atlantic Mining NS Inc.
6749 Moose River Road, RR#2
Middle Musquodoboit, NS B0N 1X0

Re: Touquoy Mine Gold Project, Moose River, Nova Scotia
2020 Annual Wetland Compensation Report

1.0 INTRODUCTION

Atlantic Mining NS Inc. (AMNS) is currently operating the Touquoy Gold Mine ('TGM'), an open pit gold mine (the Project) located in Moose River Gold Mines in Halifax County, NS. AMNS has approval to alter 58.86 hectares of wetland habitat associated with the Touquoy Gold Mine. The approval # associated with the alterations is 2016-095967-04.

Condition g) iii of the Wetland Alteration Approval states:

> *iii. The Approval Holder shall submit an Annual Wetland Compensation Report by March 31 of each year, with the first update due by March 31, 2020. The Annual Wetland Compensation Report shall be prepared by a Qualified Wetland Professional and in consultation with the Nova Scotia Environment Wetland Specialist to ensure that it meets the requirements of the Wetland Conservation Policy. The Wetland Compensation Report will include an update on the Wetland Compensation Plan, and an annual progress report on the implementation of the Wetland Compensation Plan. Progress reports shall include an update on total wetland alterations and remaining alterations at the site per wetland.*
>
> *iv. The M'ikmaq, Sipekni'katik and the Kwilmu'kw Maw'klusuaqn shall be engaged throughout the development of compensation plans. Details of these engagement activities shall be included in the Annual Wetland Compensation Report.*

The objective of this document is to identify the areas of wetland altered since 2016 and provide an update and outline the commitments made by AMNS to satisfy the wetland compensation requirements pertaining to these alterations. This update builds upon the 2019 annual wetland compensation report.

2.0 WETLAND ALTERATIONS

To date, determining the actual area of impact to wetland habitat across the mine site has been based on drone footage and GIS. Aerial imagery captured by the drone was overlaid upon baseline wetland locations to determine the direct interaction. In cases where an extra level of detail was required, a survey team assessed the wetland interaction in the field to confirm the alteration extent. The same process was completed in early 2021 to determine additional direct impacts that occurred in 2020. However, in addition, the wetland alteration areas discussed in this report also encompass wetlands that have been determined indirectly altered by adjacent mine infrastructure (i.e., change in characteristics and function as a result of non-physical disturbances).

The areas discussed above are reported in detail within the 2020 Annual Post Construction Wetland Monitoring Report (provided under a separate cover).

The results of this process has determined that a total of 48.61 ha of wetland habitat has been altered as of December 2020 across the Project Site.

Table 1 (below) identifies the direct alteration areas that has been completed for the Project to date as well as the wetlands areas that are considered indirectly impacted. *Note: wetland alterations areas have been rounded to two decimal places.*

Table 1: Wetland Alteration Areas

Wetland ID	Direct Impact Alteration Area (ha, as of Dec 31, 2020)	Indirect Impact Alteration Area (ha, as of Dec 31, 2020)
1	25.72	0.00
2	6.28	0.22
3	0.00	0.00
4	0.45	0.00
5	0.33	0.00
6	1.66	0.00
7	0.39	0.02
8	1.00	0.00
10	0.31	0.00
11	0.33	0.10
12	0.01	0.00
13	0.88	0.04
14	0.82	0.00
15	0.99	0.00
16	0.16	0.00
17	0.02[1]	0.00
18	0.23	0.00
19	0.00[1]	0.00
20	0.00[1]	0.00

Wetland ID	Direct Impact Alteration Area (ha, as of Dec 31, 2020)	Indirect Impact Alteration Area (ha, as of Dec 31, 2020)
21	0.07[1]	0.00
22	1.70	0.06
23	0.00[1]	0.00
24	0.57	0.00
25	0.11	0.00
26	0.00	0.00
27	2.68	0.00
28	0.37	0.00
29	1.59	0.66
30	0.44	0.01
31	0.06	0.00
32	0.00	0.00
36	0.01	0.00
40	0.07	0.00
42	0.00	0.00
43	0.12	0.00
44	0.00	0.00
45	0.13	0.00
Totals	**47.50.[1]**	**1.11**
Grand Total		**48.61**

[1] In error, the alteration areas in wetlands 17, 19, 20, 21 and 23 were over reported in the 2019 PCM report. The correct and up to date alteration areas for these wetlands has been corrected in Table 1 as of December 31, 2020.

Based on the alterations to date, at a replacement ratio of 2:1, 97.22 ha of compensation are required to be fulfilled by January 1, 2025.

3.0 WETLAND COMPENSATION

Wetland compensation has been ongoing since 2016 to meet the requirements for the Touquoy Gold Mine. Various methods have been used to satisfy a portion of the total wetland compensation requirements for the Project (48.61 ha) and AMNS continue to identify more opportunities to meet the goal of completing compensation before 2025. Wetland compensation completed to date is provided in Table 2. Ongoing and future wetland compensation is described in the sections that follow.

As per Condition g) i of the Approval document, up to 50% of the wetland compensation requirements can be completed via Secondary methods and a minimum 50% can be completed using Primary (on the ground) methods.

Table 2: Touquoy Gold Mine Wetland Compensation

Compensation Type	2016	2017	2018	2019	2020
Primary Wetland Compensation	11.9 ha (Completed under Cove Road LOU)		Site identification and engagement.	Otter Brook planning, baseline monitoring and permitting. See Section 3.1.	Otter Brook construction commenced in Fall 2020 and to be finalized in Summer 2021. The project will account for 10 ha of restoration area. See Section 3.1 below.
Secondary Wetland Compensation	15 ha WESP Study (see Section 3.3 below regarding outstanding work)			SMU Mesocosm Research Study planning, scoping and agreements See Section 3.2.	7 ha Year 1 SMU Mesocosm Research Study initiated during 2020.
Total Compensated (ha)	**26.9ha**		**0ha**	**0ha**	**7 ha**

Based on the total wetland compensation requirements (48.61 ha) and the compensation completed to date in Table 1, the following Primary and Secondary wetland compensation is required to be completed:

- Up to 26.61 ha Secondary Wetland Compensation; and,
- A minimum of 36.71 ha of Primary Wetland Compensation

Efforts in 2020 included the initiation of the Primary compensation project at Otter Brook and the first year of implementing the SMU Mesocosms Research Project. These are described in more detail below, along with future opportunities that have been identified.

3.1 Otter Brook Primary Wetland Compensation Project

MEL completed and submitted to NSE the initial concept design for Otter Brook in May 2020 and applied for the necessary permits to alter the on-site watercourses. A final Landowner agreement was executed in April 2020.

Construction of the Project initiated in October 2020. Delays to starting construction occurred as a result of some small-scale redesign and working around suitable weather conditions. The initial concept design is provided in Appendix A.

As per the attached concept design, the following activities were completed in 2020:

- Flag off construction areas and identify access points and equipment routes within Project Site;
- Install temporary crossing over the onsite watercourse (ditch) to gain access to the main field;

- Grub out and excavate the ponds; and,
- Initiate grubbing of the northern shallow berm/tractor trail.

Construction terminated in December 2020 once weather conditions prevented work from continuing. Construction is planned to resume in June 2021 once surface conditions allow with an anticipated finish date of the end of July. MEL will initiate post construction monitoring of the project upon completion of construction and provide NSE a project completion report in late 2021.

Approximately **10 hectares** of the restored wetland area will be applied towards the Touquoy Primary Wetland Compensation requirements. This will be discussed further in the 2021 Annual Wetland Compensation Report.

3.2 Wetland Mesocosms Research Study

3.2.1 Background

As described in the 2019 Wetland Compensation Plan, in December 2019 NSE formally accepted the concept of AMNS funding a portion of the Wetland Mesocosms Research Study as a method of Secondary Wetland Compensation. The study is being completed by the Dynamic Environmental and Ecological Health Research (DEEHR) group at Saint Mary`s University (SMU). A copy of NSE's support for the study as a Secondary Wetland Compensation Project is provided in Appendix B.

A Collaborative Research Agreement was signed between AMNS and SMU in July 2020. In addition, a Letter of Understanding (LOU) between the same parties for the 2020 financial contribution was also signed in July 2020. A copy of the 2020 LOU is provided in Appendix B.

The Agreement with SMU commits AMNS to providing funds to the study on an annual basis up to and including 2024. Annual contributions to the study will be up to $210,000 per year with an associated wetland compensation credit of $3 per m^2 as per communication with NSE. Based on this arrangement, the following Secondary Wetland Compensation requirements are proposed to be met in contribution towards Secondary Wetland Compensation requirements associated with AMNS requirements.

- 2020: Annual contribution of $210,000 equivalent to 7 hectares of wetland compensation credit. **This contribution has been paid**;
- 2021: Annual contribution of $210,000 equivalent to 7 hectares of wetland compensation credit. **A 2021 LOU for this financial contribution is provided in Appendix B**;
- 2022: Annual contribution of $210,000 equivalent to 7 hectares of wetland compensation credit;
- 2023: Annual contribution of $210,000 equivalent to 7 hectares of wetland compensation credit; and,
- 2024: Annual contribution of $168,300 equivalent to 5.61 hectares of wetland compensation credit.

3.2.2 Study Progress

SMU have completed an update report for activities completed during 2020 and a summary of work tasks planned for 2021. The report is provided in Appendix B. The five-year study was initiated in August 2020 and is currently progressing well and on schedule.

3.3 2016/2017 WESP Study

As discussed in previous wetland compensation reports (and as indicated in Table 1 above), AMNS were issued 15 ha of Secondary Wetland Compensation in 2016 as a result of completing the WESP Calibration Study. However, the final task associated with the 2016 WESP Calibration Study (NSE support for implementation of the Study) has been partially completed. MEL have been in communication with NSE since 2017 regarding fulfillment of this task, but an approach to fulfill the compensation obligations has not been defined between NSE and MEL to date. This has resulted in $25,000 worth of contributing effort remaining to be used. In order to expedite closure of the 2016 WESP Study compensation, on March 24, 2021 MEL Senior Project Manager Andy Walter discussed an alternative option to fulfill the remaining effort with NSE Wetland Specialist Ian Bryson.

The alternative option discussed was for MEL to assist NSE in the completion of a wetland biodiversity study to better understand triggers of Wetlands of Special Significance (WSS) in Nova Scotia. The scope of the Study would include completion of field surveys within wetlands that have a higher likelihood to trigger a WSS designation. This would be achieved through the completion of environmental field inventories to understand the potential presence of unique habitats, rare species assemblances, presence of Species at Risk (SAR) and Species of Conservation Interest (SOCI) and identify other highly functioning attributes within wetlands that could collectively (or individually) trigger a WSS designation. AMNS also propose to include indigenous specialists in the study to assist the MEL team. This will include identification of traditional values with the wetlands being assessed. An additional aspect of the study would be to field truth wetland boundary locations identified through a LiDAR model being developed by NSE.

MEL recommends that a defined scope of work to complete this study be developed with NSE prior to May 31, 2021 and that implementation occurs during summer 2021 to fulfill the effort remaining from the 2016 WESP Study.

3.4 Future Primary Wetland Compensation Opportunities

AMNS continue to explore valuable Primary Wetland Compensation opportunities to fulfill the requirements of wetland alteration approval conditions. One such project that has been secured for a future wetland restoration project is the Upper Musquodoboit Floodplain Restoration Project and floodplain restoration along the Gays River in Milford, NS. These projects are discussed in more detail below.

3.4.1 Upper Musquodoboit Floodplain Restoration Project

Currently existing on privately owned, agricultural land, this Project lies adjacent to the Musquodoboit River in Upper Musquodoboit, NS (Figure 1, below). This land which is used for pasture receives water from an upstream watercourse, drainage channels and wetland habitat and has been drained through excavation of deep (1-2 m) drainage ditches. In addition, during wetter periods of the year the field is flooded by the Musquodoboit River overflowing its banks.

The field currently exhibits wet areas including the presence of deep peaty soils, evidence of hydrophytic vegetation and positive wetland hydrological indicators. However, wetland conditions are marginal and are affected by the presence of the ditches. Prior to installation of the ditch network, the land would have existed as a floodplain wetland comprising graminoids and shrubs similar to adjacent, natural lands.

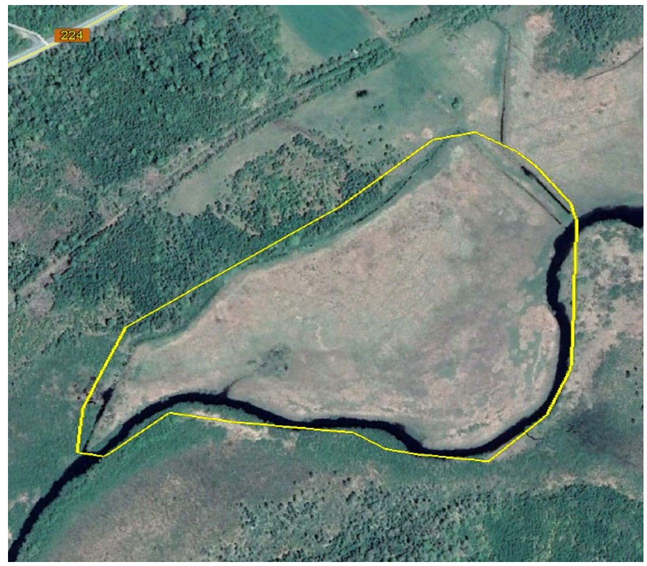

Figure 1: Musquodoboit River Restoration Project

This Project presents an opportunity to restore approximately 12 hectares of wetland habitat by redirecting water sourced via upstream features across the field by eliminating the ditches and recontouring the field surface.

MEL have an access agreement with the landowner and completed a full season of baseline monitoring during 2020 including wetland delineation, groundwater monitoring, vegetation assessments and fish habitat evaluation.

There is also potential for this project to encompass fish habitat creation. MEL are currently exploring this option with AMNS and the landowner. An agreement is planned to be in place with the landowner and AMNS later in 2021.

MEL will continue to develop a concept design for the Project and will submit a plan to NSE for review and comments in 2021. Should fish habitat creation be included the Project Team will also require approval from the Department of Fisheries and Oceans (DFO).

3.4.2 Gays River Floodplain Restoration

As discussed in previous wetland compensation annual reports, a potential floodplain restoration project has been identified along the banks of the Gays River in Milford, NS (Figure 2, below). This tract of land is owned by two landowners that MEL have recently obtained permission to perform baseline monitoring within. The land lies 300 m south of the confluence of the Gays River and the Shubenacadie River (which is known to support populations of the Atlantic Salmon Inner Bay of Fundy Population – a SAR) and has historically been used for hay production. This region is also known for supporting populations of Wood Turtle (also a SAR).

The potential restoration area includes the former agricultural land, where water has been re-directed through a series of multiple ditched drains and an old aboiteau at the northern outflow channel. Based on information provided from the landowner, and historical aerial photos the restoration area includes land that formerly comprised the natural channel of the Gays River prior to it being realigned into its straightened channel that we see today.

Figure 2: Gays River Floodplain Restoration Project

Although unrelated to AMNS's wetland compensation requirements for Touquoy, there is potential for this project to incorporate fish habitat creation; this will be further investigated as the concept design develops throughout 2021.

This restoration project would constitute the return of natural floodplain habitat by eliminating the water control methods currently being used and restoring a hydrological regime indicative of a natural floodplain habitat. There is potentially up to 40 ha of wetland restoration areas associated with the project a portion of which could be utilized to meet AMNS' wetland compensation requirements for the Touquoy Gold Mine.

3.5 Engagement

As discussed in Section 3.3, AMNS are currently engaged in a contract with SMU to complete the Wetland Mesocosms Research Study. A meeting has been proposed by AMNS and SMU with the KMNKMO in the coming months to discuss potential involvement of the Mi'kmaq in the research study in the future.

In addition, as per information provided in Section 3.3, AMNS propose to complete a biodiversity study within wetlands during 2021 to assist NSE in identifying suitable triggers for determining wetlands a WSS. AMNS are proposing to engage the KMKNO in Spring 2021 and involve them in this study. The intention is to add value to the study by increasing the indigenous knowledge and values related to evaluating the functions of wetlands in NS and potential WSS designation. This will include identification of flora and fauna considered important to indigenous people and communities as well as other wetland functions that may be of relevance.

4.0 SUMMARY

Utilizing the wetland compensation areas in Table 1, and future wetland compensation options discussed in the following sections, an estimated timeline of wetland compensation between now and the end of 2024 is presented in Table 2 (below).

Table 2: Wetland Compensation Timeline

Year	**COMPLETED**	**2016**	**2017**	**2018**	**2019**	**2020**	**FUTURE/ POTENTIAL**	**2021**		**2022**		**2023**	**2024**	**TOTAL**
Projects		WESP and Cove Road		N/A	N/A	SMU Study		SMU Study	Otter Brook	SMU Study	Upper Musquodoboit	SMU Study	SMU Study	
Compensation Area (ha)		26.9		0	0	7		7	10	7	12	7	7	**83.9**

As can be seen, based on compensation already completed, the SMU Study, and future projects which have been secured though landowner agreements, there is potential for 83.9 ha of wetland compensation area credit to be applied towards the total Touquoy requirement of 97.22 ha by 2024. MEL and AMNS continue to evaluate wetland compensation opportunities including the potential use of the Gays River project. An update on the progress of all sites discussed in this report will be provided in the 2021 Wetland Compensation Report.

If you have any questions or comments, please do not hesitate to contact me at (902)-441-2639.

Respectfully submitted,

Thank you,

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CC.
James Millard - Atlantic Mining NS Inc.
Danielle Finlayson - Atlantic Mining NS Inc.

ATTACHMENTS

APPENDIX A: Otter Brook Restoration Project Documents
APPENDIX B: Wetland Mesocosms Research Study Documents

APPENDIX A: Otter Brook Restoration Project Documents

Otter Brook, NS
Wetland Restoration Concept Plan

Prepared by:
McCallum Environmental Ltd.
2 Bluewater Road, Suite 115
Bedford, NS
B4B 1G7

May, 2020

EXECUTIVE SUMMARY

McCallum Environmental (MEL) is proposing to restore a degraded wetland located on agricultural privately-owned land near the community of Otter Brook, Nova Scotia (Figure 1, Appendix A). The proposed activity is planned to start in Summer 2020.

The proposed restoration site (known as the Project Site) is located on lands formerly utilized for hay production. Water from the land is actively drained via multiple anthropogenic ditches historically created to improve growing conditions. The ditches are connected to Otter Brook which drains to the Stewiacke River located approximately 300m downstream. The ditches are particularly effective in draining the land during periods of high flow when water levels in the Stewiacke River are high and back up into Otter Brook and the Project Site.

McCallum Environmental (MEL) is proposing restoration of the Project Site through ditch plugging, construction of diversion channels, and re-contouring of the land to achieve wetland conditions. The purpose of this document is to outline the existing conditions at the Project Site and present the preliminary design prior to implementation of the restoration project during summer 2020.

In support of developing a concept plan for the restoration project MEL completed background research and field surveys to understand baseline conditions. The purposes of this process is to understand the potential environmental constraints present and identify site specific mitigation that may be required to implement the Project. Baseline studies across the Project Site included a review of Species at Risk (SAR) and SAR habitat, extent of wetlands and watercourses, soil and vegetative conditions, and a detailed analysis of hydrology (via the installation of water level loggers) across the Project Site. In addition, MEL implemented a detailed topographical survey across the Project Site as well as the completion of a Hydrotechnical Analysis to inform and refine the design process.

The objectives of the restoration project are to improve water detention and storage capacity within the Project Site, notably after backwatering has occurred from Otter Brook and after periods of high flow. In addition, reintroduction of water (and subsequent wetland habitat) will increase the habitat variability present across the Project Site. Habitat across the Project Site is expected to transition to a community of shrub swamp interspersed with areas of marshy habitat and open ponded areas. These habitat types will improve habitat for breeding birds, amphibian, reptiles and waterbirds.

MEL are waiting for approval from NSE to alter the mapped watercourse (which exists as a drainage ditch) present in the Project Site. A landowner agreement is in place and the restoration project is planned to initiate in Summer 2020, with an expected completion during Fall 2020.

TABLE OF CONTENTS

1.0 INTRODUCTION

McCallum Environmental (MEL) is proposing to restore a degraded wetland located on agricultural privately-owned land near the community of Otter Brook, Nova Scotia (Figure 1, Appendix A). The proposed activity is planned to start in Summer 2020.

The proposed restoration site (known as the Project Site) is located on lands formerly utilized for hay production. Water from the land is actively drained via multiple anthropogenic ditches historically created to improve growing conditions. The ditches are connected to Otter Brook which drains to the Stewiacke River located approximately 300m downstream. The ditches are particularly effective in draining the land during periods of high flow when water levels in the Stewiacke River are high and back up into Otter Brook and the Project Site.

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1.2 Property Information

The restoration project will be completed on agricultural land within adjoining properties PID#20341426 and PID#20050563 in Otter Brook, NS.

Property ownership details are provided in Table 1.

Table 1: Restoration Lands Information

Community Name	Otter Brook (Map 11EO3)
County Name	Colchester County
Property Identification #	20341426, 20050563
Property Owner	David Arthur Kennedy
Coordinates (central)	496238 mE, 5007916 mN

MEL and the landowner have an Agreement in place to complete the wetland restoration activity described in this document.

1.2.1 Historical Land Use

Up until as recent as 2018 the Project Site has been used for harvesting hay, however, in recent years has been left fallow. A review of aerial photos dating back to 1938 was completed to compare land use conditions within the Project Site. As can be seen on Photos 1 and 2 (below) the majority of the land had been cleared and ditched in 1938 and appeared to be in active agricultural use. One notable difference is identified in the eastern section of the Project Site where a dense vegetative cover appears to exist in 1938. Based on photo interpretation this cover type appears to of shrubby composition and is expected to have extended westward prior to historical draining and clearing taking place. Based on anecdotal information from the landowner, the installation of drainage ditches was employed as a method to drain the water from the land, especially during periods when the Stewiacke River and Otter Brook back-watered into the Project Site. It is anticipated that prior to the ditching and vegetation clearing, the land existed as a shrub swamp which likely experienced very wet conditions during the spring and intermittently throughout the year during high flow conditions and backwatering from the downstream aquatic features. The linear ditching, which are concentrated in central and eastern portions of the Project Site, have been used to drain the land, reduce surface water detention post backwatering events and encourage the establishment of suitable vegetation for hay making practices. Additional information regarding hydrological conditions is provided in Section 3.3.

Photo 1: Aerial photo of Project Site in 1938

Photo 2: Aerial photo of Project Site in 2019

1.3 Project Team

A project team was assembled for the completion of this restoration project. The team was selected based on level of proficiency in their respective roles. The team members and their individual roles are presented below.

Table 2: Project Team

Team Member	Role
Andy Walter, BSc. (Hort)	Project Manager
Matt Delorme	Hydrotechnical Engineer
Amber Stoffer	Field Biologist and Wetland Specialist
John Gallop	Field Biologist and Report Writer

Curriculum Vitae for the above-mentioned team members are provided in Appendix B.

2.0 BASELINE CONDITIONS

In support of developing a concept plan for the restoration project, MEL completed background research and field surveys to understand baseline conditions. The purposes of this process is to understand the potential environmental constraints present and identify site specific mitigation that may be required to implement the Project.

The following sections outline the methods and results of the determining the baseline conditions within the Project Site and surrounding lands.

2.1 Methods

2.1.1 Desktop Review

A background information review of watercourses and wetlands was completed using the Nova Scotia Topographic Database (NSTDB) and Wet Areas Mapping (WAM) databases, flow accumulation channels, the Nova Scotia Environment (NSE) Wetlands database, and the provincial Tertiary Watershed database. In addition, the NSE "Wetlands of Special Significance" (WSS) database was reviewed as part of this process.

Data was requested from the ACCDC to obtain records of rare species existing or historically found within the general location of the Project Site. This database provides information regarding priority species within the Project Site.

In order to be considered a priority species, a species must meet one of the following criteria:

1. Listed in the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Federal Species-at Risk Act (SARA 2003). All species listed as Endangered, Threatened, or of Special Concern;
2. Nova Scotia Endangered Species Act (NSESA 1999). All species listed as Endangered, Threatened, or Vulnerable; and,
3. Conservation Rank: All Species designated as S1, S2, or S3 as defined by Atlantic Canada Conservation Data Center (ACCDC 2019).

The Provincial Landscape Viewer (https://nsgi.novascotia.ca/plv/) was also reviewed to determine whether the Project Site is within, or adjacent to special features, such as protected areas, Atlantic Coastal Plain Flora buffer, Mainland Moose Concentration Areas, and Significant Habitats. To determine in the Project Site is with any ecologically sensitive regions, the following databases were also checked: boreal felt lichen predictive layer, critical SAR habitats, protected water areas, parks and protected areas, RAMSAR sites, Important Bird Areas (IBAs), and Canada Wildlife Service (CWS) migratory bird sanctuaries.

A short list of the Species at Risk (SAR) recorded in the ACCDC report was compiled based on habitat types present in the Project Site.

2.1.2 Field Assessment

To determine the baseline conditions of the Project Site, a suite of biophysical surveys was completed including: wetlands and watercourses, vegetation, hydrology, soils, priority species and fish.

2.1.2.1 Wetlands and Watercourses

During field assessments, the Study Team surveyed the Project Site to confirm the presence of mapped wetlands and watercourses.

> Wetlands are:
> *Land referred to as a marsh, swamp, fen, or bog that either periodically or permanently has water table at, near, or above the land surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation, and biological activities adapted to wet conditions.*
>
> Watercourses are:
> *The bed and shore of every river, stream, lake, creek, pond, spring, lagoon or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and all groundwater.*

The wetland and watercourse assessments occurred on August 9, 2018 and July 3rd, 2019 by MEL qualified biologists.

2.1.2.2 Hydrological Conditions

Detailed hydrology surveys were completed through the installation of five shallow monitoring wells across the Project Site. Monitoring wells were installed on June 13th, 2019 and equipped with a Solinst Level logger to measure groundwater fluctuations until December 2019. MEL calibrated the level loggers with the atmospheric pressure data collected by a barologger already in use located ~ 28km southeast, and within 300m of elevation of the Project Site. The objective of the program was to understand the detailed hydroperiod within the Project Site including the hydrological response to periods of high flow and backwatering events. The hydroperiod refers to the seasonal pattern of the water level that results from the combination of the water budget and the storage capacity of the wetland. The water budget is a term applied to the net of the inflows, all the water flowing into, and outflows, all the water flowing out of, a wetland (*Welsch et al,* 1995).

A Solinst levelogger was deployed in each of five monitor wells. Each levelogger was labeled with the established location and attached to a j-plug with a string and a measurement of the length from the attachment point to the end of the levelogger (i.e. the levelogger depth). The levelogger will then lowered into the monitor well.

The leveloggers were programmed to collect data every hour with a total survey effort of 24 data collection events/day.

In addition to information collected via the leveloggers, visual hydrological observations were recorded across the Project Site to gain a general understanding of hydrology characteristics.

Table 3 (below) and Figure 2 (Appendix A) provides details and the location of the Monitoring Wells.

Table 3. Monitoring Well (MW) Locations

MW#	Coordinates (UTM, NAD83)	
	Easting	Northing
1	495984	5007900
2	496092	5007934
3	496179.8	5007984
4	496284.7	5007805
5	496349.1	5008014

2.1.2.3 Vegetation

During the site visit on July 3rd, 2019, vegetation community types were documented throughout the Project Site. A 1 m radius surrounding the monitoring wells (Figure 2) were surveyed and a plant list was created for each location. Additional plants that were not observed at the monitoring well location vegetation plots but within the Project Site were also recorded. Priority species were georeferenced and recorded.

2.1.2.4 Soil

On August 9th, 2018, soil pits were assessed to determine baseline soil conditions within the Project Site. Approximate soil depths and texture was documented for each soil horizon.

2.1.2.5 Priority Species

The priority species assessment occurred concurrently with the wetland, watercourse and vegetation assessment on July 3rd, 2019 and the ACCDC report was referenced prior to the site visit. Any priority species observed during the surveys were recorded and georeferenced.

2.1.2.6 Fish

Potential for fish and fish habitat was assessed within the Project Site on July 3rd, 2019, by visual assessments and the deployment of 3 minnow traps within an on-site drainage ditch (known as D2) for approximately 6 hours (Figure 2). Watercourse/drainages were assessed for the water quality parameters - pH, temperature, conductivity and TDS and fish habitat suitability (e.g. watercourse depth, width, substrate, habitat types etc.) and the presence of any barriers (both permanent and seasonal). Fish collection survey details are provided in Table 3 (below):

Table 4: Otter Brook Fish Collection Survey Details

Location	Trap ID	Trap Coordinates (UTM, NAD83)		Survey Effort
		Easting	Northing	
D2	Minnow Trap 1	496109	5007727	6h13m
	Minnow Trap 2	496162	5007802	6h10m
	Minnow Trap 3	496236	5007916	6h11m

2.2 Results

2.2.1 Desktop Review

A review of the NSDTB watercourse and NSE wetland habitat database identifies mapped wetlands to the east, west and south of the Project Site. A small portion of a marsh is located on the western extent of the Project Site (Figure 3, Appendix A). No WSS are located within the Project Site, however, several are located west, south and east approximately 200 m to 600 m outside the Project Site boundary.

As can be seen on Figure 2 (Appendix A), the NSTDB identifies two watercourses within and two directly adjacent to the Project Site. The primary watercourse bisects the Project Site from north to south and has been identified as Ditch 2 (D2) on Figure 2 (Appendix A). The second watercourse within the Project Site skirts the eastern Project Site boundary, however, field observations confirmed that this feature does not exist on the landscape. A receiving mapped watercourse (known as Ditch 3 [D3]) intercepts water from D2 and drains westward towards Otter Brook. Otter Brook itself drains from northeast to southwest and at its closest location is mapped approximately 10m west of the Project Site boundary. The flow accumulation lines, in part, coincide with the watercourse layer, however, there is an additional flow accumulation line originating from the western third of the Project Site and flows west to Otter Brook (Figure 3, Appendix A) which eventually flows into the Stewiacke River. The WAM database identifies potential wetland habitat within the Project Site with groundwater levels within 0.5 m of the surface and well as the lands surrounding it.

The wetlands and watercourses discussed above are discussed in more detail in Section 2.2.2.

The Stewiacke River is home to a diverse fish community, including marine and euryhaline species in its lower tidal estuary, and diadromous and freshwater species which may be found within the upper reaches of the watershed. Species documented within the Stewiacke River that may utilize freshwater habitats at some point of their lifecycle include: American eel, sea lamprey, brook trout, brown trout, yellow perch, white sucker, Atlantic salmon, shad, gaspereau, blueback herring, rainbow smelt, striped bass, chain pickerel, and a variety of forage fish (i.e. sticklebacks, shiners).

The ACCDC identified the following records of SAR, SOCI and Special Areas within 5 km of the Project Site including:

- 3 managed areas;
- 1 location sensitive SAR: Black Ash;
- 174 records of 30 vascular flora;
- no records of nonvascular flora;
- 175 records of 36 vertebrate; and,

- no records of invertebrates.

The NS Provincial Landscape Viewer identified Significant Habitat within the Stewiacke River and some of its tributaries, which were confirmed to be presence of Wood Turtle and Triangle Floater (F. MacKinnon, NSE, personal communication, August 01, 2017).

The Project Site is not located in any protected or conservation areas within federal, provincial, or municipal jurisdiction. Figure 4 (Appendix A) shows the Project Site and surrounding significant habitats and conservation areas. The Nova Scotia Provincial Landscape Viewer and desktop review identified the following:

- The Project Site is not within an Atlantic Coastal Plain Flora buffer.
- The Project Site is not within a moose concentration area.
- The Project Site is within a deer zone.
- The closest mapped Significant Habitat is for Bald Eagle (CO117), it is located approximately 300 m northeast of the Project Site. This bald eagle observation was made in 1998 . Bald Eagles are listed as S5 and are neither SAR nor SOCI.
- An additional Significant Habitat (CO344) is located 230 m south west of the Project Site for wood turtle (*Glyptemys insculpta*). An observation of wood turtles and their eggs were observed in 2003.
- The Project Site does not contain any predictive boreal felt lichen polygons. The closest habitat polygon is approximately 22 km to the south.
- The Project Site does not contain any current or proposed critical SAR habitat.
- The Project Site does not contain any RAMSAR designated wetlands. The closest RAMSAR wetlands are in the Southern Bight, Minas Basin, approximately 53 km to the south.
- The Project Site does not fall within any IBAs. The closest IBA, Cobequid Bay (NS019), is approximately 33 km to the north west.
- The Project Site does not fall within any CWS migratory bird sanctuaries. The closest sanctuary, Boot Island National Wildlife Area, is approximately 95 km north west.

The Project Site is located 2.8 km to the northwest of the Stewiacke River Eastern Habitat Joint Venture and 1.6 km southwest of the Otter Brook Eastern Habitats Joint Venture which are listed as Managed Areas under the ACCDC report. These areas have been designated as such due to their importance as floodplain and waterbird breeding habitats.

A short list of SAR and their habitat requirements were evaluated in the following section. All species on the short list were considered during the field evaluations. A brief description of the habitat suitability found in the Project Site for each species is discussed below.

- Canada warbler (*Cardellina canadensis*)
- Common nighthawk (*Chordeiles minor)*
- Olive-sided flycatcher (*Contopus cooperi)*
- Chimney swift (*Chordeiles minor*)
- Black ash (*Fraxinus nigra)*
- Bobolink (*Dolichonyx oryzivorus*)

- Barn swallow (*Hirundo rustica*)
- Bank swallow (*Riparia riparia*)
- Snapping turtle (*Chelydra serpentina*)
- Short-eared owl (*Asio flammeus*)
- Wood turtle (Glyptemys insculpta)

Below are the habitat requirements for the SAR listed above:

Canada Warbler

Canada warbler (SARA Threatened; NSESA Endangered) breed in a variety of forested habitats with dense understory vegetation (Environment Canada 2016a). Canada warbler typically breed in swamps with a dense shrub layer. The Project Site is an open habitat (agricultural field). Suitable Canada warbler breeding habitat is not present within the Project Site.

Common Nighthawk

Common nighthawk (SARA: Threatened) has a specific breeding habitat within sparsely vegetated or bare ground in open "wastelands" such as pine barrens, forest cut-overs, grasslands, pastures, or burns, and secondarily on flat roofs of buildings (Environment Canada 2016b). Suitable breeding and foraging habitat for common nighthawk is present within the Project Site.

Olive-sided Flycatcher

The olive-sided flycatcher (SARA/NSESA Threatened) is found in open woodlands and other places where scattered trees remain after cutting or fire in forested regions and are usually located near water or wetlands (Environment Canada 2016c). The Project Site consists of agricultural lands and olive-sided flycatcher habitat is not present.

Black Ash

Black ash is usually found on poorly drained soils and in swampy woods (NSDNR 2015). Black ash may also be found in bogs, near streams, in peat and mucky soils, and in fine sandy soils that are underlain by sandy till (Boreal Forest 2014). Black ash habitat is not present within the Project Site, however, there may be suitable habitat in the treed areas adjacent to the Project Site.

Wood Turtle

The Wood Turtle (SARA: Threatened) requires sandy or gravely-sandy bottoms and prefers clear meandering watercourses. They also are found within bogs, marshy pastures, beaver ponds, shrubby cover, meadows, coniferous and mixedwood forests, hay and agricultural fields and pastures. To overwinter, the Wood Turtle needs a mean water depth of 91.2 ± 34.8 cm, within microhabitat which includes buried in mud, under overhanging banks or resting on the bottoms of the stream pools (Environment Canada, 2016). Contiguous areas of standing water within the Project Site (through additional agricultural ditching) provide potential overwintering habitat for Wood Turtle in the ditches as a result of suitable water depths and fine substrates. However, no suitable nesting habitat for Wood Turtle is present within the Project Site.

Snapping Turtle (SARA Special Concern)

Although snapping turtles (SARA: Special Concern) occupy a wide variety of habitats, the preferred habitat for this species is characterized by slow-moving water with a soft mud bottom and dense aquatic vegetation. Established populations are most often found in ponds, marshes, swamps, peat bogs, shallow bays, river and lake edges, and slow-moving streams. The Snapping Turtle hibernates usually near the shore, at the bottom of lakes and rivers within the mud or silt, while nesting sites occur generally on sand or gravel banks near the water (Environment and Climate Change Canada, 2016). Contiguous areas of standing water within the Project Site (through agricultural ditching) provide suitable overwintering habitat for Snapping Turtle as it prefers slow-moving water with a soft mud or sand bottom and abundant vegetation. However, nesting habitat is not present within the Project Site (i.e. gravelly and sandy areas along streams).

Barn Swallow

Barn swallows (SARA: Threatened; NSESA: Endangered) are insectivores which are typically found in open habitats with wetland and waterbodies near by (Cornell University, 2019). Barn swallows often nest in anthropogenic structures such as barns and bridges. Within the Project Site, areas of open water exist which provides suitable foraging habitat for barn swallows, however, nesting sites (e.g. barns and bridges) are absent.

Bank Swallow

Bank Swallows (SARA: Threatened; NSESA: Endangered) are insectivores and have overlapping foraging habitat with barn swallows (described above). Bank swallows are often found nesting in burrows steep cliffs/sand banks near rivers/waterbodies (National Geographic, 2006). Within the Project Site, areas of open water exist which provides suitable foraging habitat for barn swallows, however, nesting sites (e.g. sand banks and cliffs) are absent.

Short-eared Owl

Short-eared owl (SARA: Special Concern) are associated with grasslands and open areas where they hunt for small mammals. Short-eared owls are ground nesters and will nest in grasses with heights of 30 to 60 cm in height (Fish and Wildlife, 2015). Breeding and hunting habitat is present with the Project Site.

Chimney Swift

Chimney Swift (SARA: Threatened; NSESA: Endangered) are a type of swallow which often forages in urban areas as well as forests, rivers, lakes and field (Cornell University, 2019). Chimney swifts will nest in often anthropogenic structures such as vents and chimneys as well as caves and hollow trees. Suitable foraging habitat is present within the Project Site.

Bobolink

Bobolinks (SARA: Threatened; NSESA: Vulnerable) are ground nesters and inhabit grassland habitats (Audobon, 2020). Suitable foraging and breeding habitat is present within the Project Site.

In addition to the SAR species discussed to have potential within the Project Site, several priority vascular flora species such as blood milkwort (*Polygala sanguinea*, ACCDC: S3), climbing false buckwheat (Fallopia scandens, ACCDC: S3) have potential to be within the Project Site at its current condition. A series of wetland plant species which are in close proximity to the Project Site may also have potential to inhabit the Project Site, once restored, and include: bog willow (*Salix pedicellaris,* ACCDC: S2), marsh mermaidweed (*Proserpinaca palustris*, ACCDC: S3) and large purple fringed orchid (*Platanthera grandiflora*, ACCDC:S3).

2.2.2 Field Assessment

2.2.2.1 Priority Species Field Results

An assessment for SAR and SOCI was completed during all the field evaluations completed in 2018 and 2019. No SAR or SOCI or evidence of any protected species were observed.

2.2.2.2 Watercourses and Surface Water

During the site assessment three agricultural drainages were observed, two of which are located within the Project Site and labeled D2 and D3 (Figure 2, Appendix A). D2, though presented as a watercourse by the Nova Scotia Topographic Database Mapping, exists as an agricultural ditch. This ditch is part of an extensive series of ditches that facilitate the drainage of water from the land to support agricultural hay production within the Project Site. Drainage ditches present across the Project Site are hydrologically connected to Otter Brook, which subsequently drains into the Stewiacke River Representative photographs are presented in Appendix C.

Water is currently sourced to D2 from an additional agricultural ditch drainage from the north. This drainage splits into D2 (south) and D3 (west). Occasionally, when water levels within Otter Brook are particularly high, Otter Brook backwaters into D3. D2 flows south for approximately 450 m before draining into D1, which conducts flow west to Otter Brook. Otter Brook, which flows southwest along the western property line of PID#20341426, discharges into the main reach of the Stewiacke River approximately 400 m south of the property boundary. During normal summer flow conditions, water flow within the drainage ditches throughout the Project Site is minimal to none. D2 is currently intersected by a tractor trail approximately 135 m north of its confluence with D1. A single PVC culvert extends beneath this tractor trail (see Figure 2, Appendix A).

Two field assessments were completed at the Project Site; one in August 2018 and the other in July 2019. A focus of the assessment was the conditions within D2 which requires a provincial watercourse permit in order to complete the proposed restoration activity. This permit was subsequently applied for in February 2020. During the 2018 visit, conditions were very dry within D2 and surrounding lands, however, during the July 2019 field assessment, water from the channel was observed to occasionally flood its banks into the surrounding field. The field assessment conducted on July 3, 2019 immediately followed heavy rainfall in late June, which corresponded to high water levels within Otter Brook. During normal flow conditions, water levels within the drainage ditches are typically much lower and do not extend into the surrounding fields. Observations made within D2 during the August 2018 and July 2019 field assessment are presented in Table 5. In-stream vegetation is present throughout all ditches within and directly surrounding the Project Site.

Table 5: D2 Characteristics

Characteristics	Details (Aug 2018)	Details (July 2019)
Water Depth	0.2 m (average)	0.15-1.2 m
Bankfull Depth	0.3 m (average)	0.15-1.2 m
Wetted Width	0.5 m (average)	0.7-5 m
Bankfull Width	0.7-5 m	0.7-5 m
Substrate	Silt: 93% Rubble: 7%	
Bank Conditions	Flat and Stable – agricultural field vegetated with graminoid species.	
Water Flow (alteration area)	Visibly stagnant/flat	

An individual chain pickerel was confirmed through visual surveys within D1. No other fish were visually observed during the field assessment, nor were any fish were captured as a result of fish trapping efforts within D2.

Although hydrologically connected to Otter Brook, D2 and D3 are considered to provide low quality fish habitat. Channel morphology of D2 is homogenous throughout, consisting entirely of a flat, stagnant reach. Bottom substrates are almost entirely composed of fines, and only limited provisioning was observed for in-channel or overhead cover. The network of agricultural ditches within the Project Site may be accessible by fish but do not provide quality habitat. In addition, in the absence of protective cover, fish that access these ditches would likely be easy prey for chain pickerel, an invasive species and voracious predator that was confirmed to be present within the Project Site.

Fisheries and Oceans Canada Consultation

A site visit was conducted by Fisheries and Oceans Canada (FOC) personnel (Shannan Murphy) and MEL Project Manager Andy Walter on November 14, 2019 to evaluate the potential habitat for fish in D2, and discuss whether fish passage would need to be constructed as part of the wetland restoration project. DFO communicated to Andy Walter that due to D2 existing as an agricultural ditch with limited habitat for fish (including upstream habitat), maintaining fish passage into D2 from D1 was not required as part of the wetland restoration project.

A provincial watercourse alteration application was submitted to NSE to alter D2 in February 2020.

2.2.2.3 Vegetation Surveys

During the vegetation assessment no priority species were observed. The community type was dominated by forbs and graminoids often found in disturbed areas (e.g *Vicia cracca* and *Euthamia gramminifolia*). The community type consisted of a mixture of species often associated with upland habitats as well as hydrophytic species which were often found in close proximity to drainage ditches within the Project Site. See Table 6 (below) for the vegetation species observed.

Table 6. Vegetation Present within the Project Site

Monitoring Well	Scientific Name	Common	S-Rank	Wetland Indicator Status
MW1	*Juncus effusus*	Soft rush	S5	FACW
	Doellingeria umbellata	Hairy flat-top white aster	S5	FAC
	Vicia cracca	Tufted vetch	SNA	FAC
	Rubus pubescens	Dwarf Red Raspberry	S5	FAC
	Euthamia graminifolia	Grass-leaved Goldenrod	S5	FAC
MW2	*Solidago rugosa*	Rough-stemmed Goldenrod	S5	FAC
	Vicia cracca	Tufted vetch	SNA	FAC
	Euthamia graminifolia	Grass-leaved Goldenrod	S5	FAC
	Doellingeria umbellata	Hairy flat-top white aster	S5	FAC
	Persicaria sp.	-	-	-
MW3	*Phalaris arundinacea*	Reed canary grass	S5	FACW
	Ranunculus repens	Creeping Buttercup	SNA	FAC
	Taraxacum officinale	Common dandelion	SNA	FAC
	Persicaria sp.	-	-	-
MW4	*Galium asprellum*	Rough bedstraw	S5	OBL
	Vicia cracca	Tufted vetch	SNA	FAC
	Juncus effusus	Soft rush	S5	FACW
	Persicaria sp.	-	-	-
	Solidago rugosa	Rough-stemmed Goldenrod	S5	FAC
MW5	*Solidago sp.*	-	-	-
	Persicaria sp.	-	-	-
	Juncus effusus	Soft rush	S5	FACW
	Spiraea alba	White meadowsweet	S5	FAC
Additional Vegetation Observed within Project Site	*Iris versicolor*	Harlequin blue flag	S5	FACW
	Rosa nitida	Shining rose	S4S5	OBL
	Alnus incana	Speckled alder	S5	FACW
	Onoclea sensibils	Sensitive fern	S5	FACW
	Acer rubrum	Red maple	S5	FAC
	Onoclea sensibilis	Sensitive fern	S5	FACW
	Impatiens capensis	Spotted jewelweed	S5	FAC
	Scirpus atrocinctus	Black-girdled bulrush	S5	FACW
	Carex stricta	Tussock sedge	S5	OBL
	Carex versicaria	Inflated sedge	S4	OBL

2.2.2.4 Wetlands and Soils

No areas of wetland habitat were identified within the Project Site, although conditions exhibiting wetland type conditions were observed in lands immediately adjacent to drainage ditches (i.e. hydrophytic vegetation [shining rose, harlequin blue flag and sensitive fern] and saturated surfaces). Small areas of wetland habitat are present in surrounding lands including a small area of shrub swamp habitat in land to the south of the Project Site adjacent to the convergence of D2 and D1 (Figure 3, Appendix A). Wet meadow habitat was also observed in PID # 20050480 located north of the Project Site, although this area was not extensively investigated due to it being located on private property.

A review of the soil conditions within soil pits completed across the Project Site indicated that in general, soil characteristics consisted of a friable loamy/clay topsoil typical of an agricultural site that has been worked over to create viable growing conditions. A clay layer was observed at depths ranging between 50cm-80cm at all soil pits. In some cases, at depths of approximately 50cm, there was evidence of dark loamy soils and saturated conditions as well as a sulfur dioxide oxide (a biproduct of anoxic conditions i.e. wetland conditions). These conditions indicate that under current conditions, water levels are occurring marginally below what is required to positively classify wetland hydrological conditions.

Although not currently existing as wetland habitat, a Wetland Ecosystem Services Protocol Atlantic Canada (WESPAC) functional assessment will be completed this summer. A post construction WESPAC assessment will also be completed during the monitoring period to compare land characteristics during the growing season.

2.2.2.6 Hydrology

In support of the hydrotechnical study for the restoration design process (and to better understand current hydrological conditions across the Project Site), data from the level loggers was collected and formatted into hydrographs for further analysis.

Detailed hydrology results including hydrographs indicating water levels within the on-site MW's are provided in Appendix D.

The US Army Corp (2009) stipulates that wetland hydrology is defined as saturation of soils 20cm below the surface or groundwater levels within 30cm of the surface for a period of two consecutive weeks in the growing season (June 01 – Sep 30). As such, recorded hydrology within the following parameters indicate positive hydrological indicators for wetland habitat:

- Relative ground water depth is greater than -30cm for at least two consecutive weeks in the growing season; and,
- Relative ground water depths do not exceed +30cm for a prolonged period.

Wetlands regularly undergo seasonal Relative Groundwater Depth (RGWD) fluctuations in response to annual precipitation, seasonal variability, and frequency of local precipitation events. Geographically isolated wetlands have been reported to have seasonal fluctuations ranging as high as ±20cm by Keddy,

2001. Conversely the same publication stated that wetlands associated with lakes and watercourses were found to have seasonal variability as high as ± 1.5m.

The relative ground water average was calculated for each of the monitor wells collected between May and December 2019 as presented in Table 7.

Table 7: Average Baseline Relative Ground Water Depths

MW ID	Baseline Average RGWD (cm)
MW 1	-46
MW 2	-54
MW 3	-29
MW 4	-51
MW 5	-31

As depicted by the hydrographs (Appendix D) and the average RGWD in Table 7, none of the MW's recorded a RGWD of greater than -30cm for more than two weeks of the growing season. MW2 and MW3 appear to be the closest in meeting these conditions during mid to late June where water levels appear within 30cm of the surface for approximately 17 days and 22 days respectively. MW4 recorded the driest conditions during the growing season (~1m below grade at the end of August). This is likely as a result of MW being situated in an extensively ditched area of the Project Site.

What is also evidenced from the hydrographs are that peaks in RGWD occur throughout the growing season in all MW's although peaks appear most pronounced in MW2 and least pronounced in MW1. This result may suggest that MW1 is located in a more stable environment and subjected to less effect from the ditching than other MW's which are located in-between extensive ditches. Additional discussion regarding the hydrology across the Project Site is provided in Section 3.3.

3.0 RESTORATION DESIGN

3.1 Restoration Objectives

A summary of the main restoration objectives is to detain water at the surface for a longer duration and in turn create and restore habitat across the Project Site. These objectives are discussed below:

1) <u>HYDROLOGICAL</u>: The restoration project will improve water detention and storage capacity of the landscape; this will be achieved by storing water within the Project Site for a longer duration. Surface water will be pooled at surface for a longer duration during the growing season, notably after high flow conditions and back-watering from Otter Brook. When pooled water is not occurring, the objective will be to increase sub-surface storage which will be evidenced by increased saturation levels. Increased water detention will lead to an increased anaerobic water regime (and hence development of organic soils), and improved water quality functions.

2) <u>HABITAT</u>: Changes to hydrology and introduction of pooled and saturated wetland conditions will create variable wetland classes which will predominantly be defined by the vegetation that colonizes them. It is probable that saturated areas that are no longer used for agriculture will

gradually grow in with shrubby vegetation already present in the surrounding area (i.e. shining rose and speckled alder shrubs). As per information provided by the landowner, these shrubby areas already provide a source of breeding habitat for birds. Therefore, the restoration project is expected to create and expand this habitat. Areas that pool water at surface for a longer duration could transition to small marshy micro-habitats; however, this will be determined by on-site infiltration and evapotranspiration rates, and associated loss of water from the surface during the warmer months.

Excavation of ponds will create an additional habitat type which is likely to provide aquatic habitat support for amphibians, reptiles and waterbirds. As discussed in Section 2.2.1 the Project Site is located approximately Otter Brook Eastern Habitats Joint Venture which has been designated as a managed area due to its importance as floodplain and waterbird breeding habitats. Therefore, ponded areas are likely to attract waterbirds to raise their young, or act as a feeding area in the deeper areas where densities of invertebrates are typically higher.

MEL have recently completed the following tasks to understand how the proposed restoration project can be implemented to meet the restoration objectives:

- Completion of topographical surveys across the Project Site;
- Completion of hydrotechnical analysis and a site hydrographs; and
- Design of restoration features and proposed land activities.

3.2 Topographical Surveys

Topographical surveys were completed across the Project Site in 2019 by Williams Nutter Limited Surveying. The objective of the surveys was to establish ground elevations across the restoration area to supplement the design process.

The survey team completed the survey across the Project Site using sub 1-meter survey grade equipment. Ground elevations and water levels in ditches within and surrounding the Project Site were recorded. This data was used to determine current water flow patterns and supplement the design and locations of restoration activities (i.e. water control structure, shallow berms, diversion channel and ponds). In addition, results of the topographical survey identified naturally occurring rises in elevation which could be utilized as part of the design process to determine the restoration area. As well, small scale elevation changes informed the habitat likely to be restored post restoration activities.

The topographical data was reviewed in detail and used in combination with the hydrotechnical analysis (Section 3.3) to determine expected water levels across the Project Site post restoration activities.

3.3 Hydrotechnical Analysis

In support of the restoration design process, EC Atlantic completed a Project Site Hydrograph. The purpose of the Hydrograph is to understand the “hydroperiod” of the site (i.e. when, how much and how long water is present). This is also known as the Depth, Duration and Timing (DDT). It is not a precise predictive tool, but rather a statistical model that aims to compare the relative performance of the area with and without the proposed control structures being implemented as part of the restoration project.

The hydrograph is a visual representation approximating the restored wetlands hydroperiod, shown as water level across the Project Site, with a datum elevation of 0.00 metres at ground surface elevation. The methodology uses the following components as part of its calculation:

Water Inputs

- Otter Brook Floodwater: anecdotal reports and monitoring data demonstrate that the site lies within the Otter Brook floodplain, with several flood events each year occurring at the site, represented as a flood stage depth;
- Indirect Precipitation, Off-Site: average monthly precipitation values for the Project Site location over a ten-year period are used in a modified rational method calculation to estimate the runoff volume conveyed to the site ditch system from catchment areas to the north;
- Direct Precipitation, On-Site: average monthly precipitation values for the Project site location over a ten-year period are used to calculate the daily precipitation inputs to the site as direct rainfall, and
- Groundwater discharge volume flowing into the Project Site should measurable data be available.

Water Outputs

- Evapotranspiration: applied to the site when water levels are within 300mm of surface and at all times to standing water within the ditch system;
- Infiltration; and
- Direct Runoff: applied to the ditch system anticipating rapid drawdown of ditch water levels following Otter Brook flood events.

Restoration Design Features

- Size of the restoration area; and
- Ditch block (i.e. water control structure) height used to prevent outflow from the existing drainage ditches, and
- Shallow Berm (i.e. weir) heights where calculated ditch block height is greater than the site datum.

The resulting hydrograph plots the calculated water storage depth within the Project Site. However, it should be noted that the water storage depth is based on the assumption that **the surface is completely flat,** whereas the actual site has topographic variations (albeit very subtle). The calculations are performed using site characteristics at a representative monitoring well, in this case, Monitoring Well 3 (MW3). The water storage depth calculation is used considering these assumptions to develop a grading plan specifying physical groundwork across the Project Site to achieve the objectives of the restoration project for **actual water depths** that can be expected across the Project Site.

3.3.1 Existing Conditions

The wetland area, historically expected to exist as a low-lying marshy floodplain of Otter Brook, has had drainage channels excavated throughout to reduce groundwater levels and accelerate drainage following backwatering from high flow events in Otter Brook (and the Stewiacke River).

The existing site is relatively flat with a slight gradient to the southwest toward Otter Brook. Average topography throughout the site ranges from elevation 17.9m to 18.1m. The site has slightly rolling topography with localized high and low areas around the perimeter. Based on interviews with the landowner and site visits during the investigation period, the site experiences high water levels up to 800mm above existing ground during the spring freshet and periodic flood events through the remainder of the year. Flood depths and groundwater response were monitored between June 14, 2019 and December 6, 2019, which confirmed this anecdotal information. Because of the excavated drainage channels, surface water subsides immediately following the flood events, while groundwater levels subside over a period of thirty to eighty hours following a flood event. The presence of the drainage channels ensures that during the summer months, high groundwater on site is limited to a one- or two-day period during Otter Brook floods. Figure 1 (below) shows the monitoring well data at MW3 for the 2019 growing season.

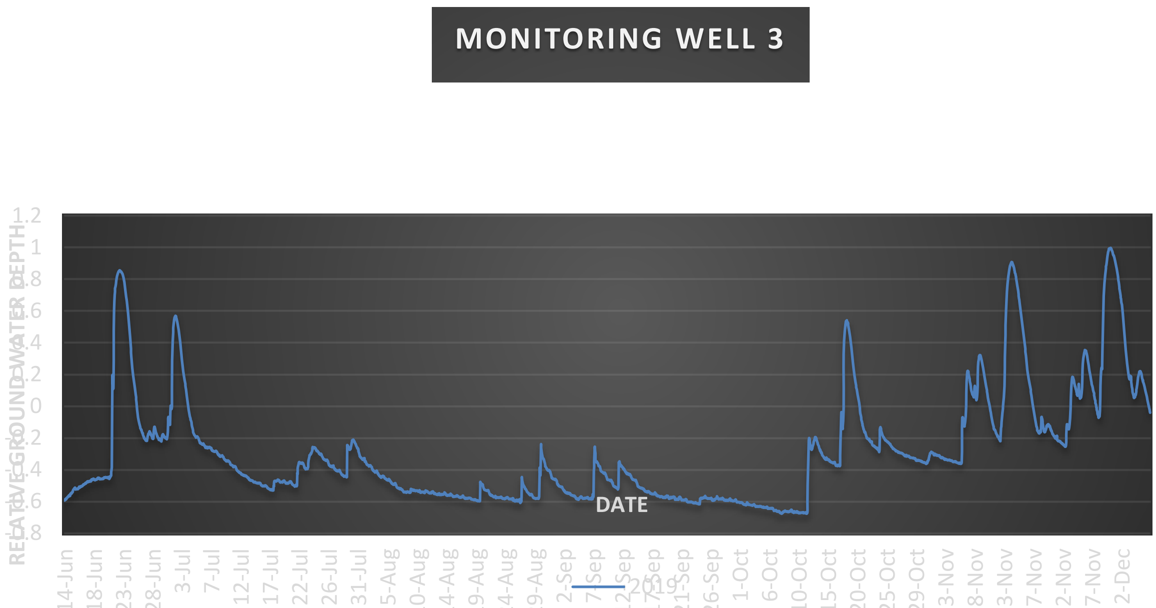


Figure 1: 2019 Monitoring Well Data

<u>3.3.2 Analysis Methodology</u>

In order to conduct the analysis and estimate the effect of the proposed restoration activities, the site was assessed using a modified methodology based on *Wetland Mitigation: Planning Hydrology, Vegetation and Soils for Constructed Wetlands.* The steps used to define the ditch block and berm levels are:

1. The referenced hydrograph method was modified to expand the model from monthly inputs to hourly inputs throughout the year. This is required to assess the impacts of daily storms and short duration Otter Brook flood events on water levels.
2. Environment Canada Rainfall gauge data was used to correlate daily rainfall depths with flood stage in Otter Brook based on MW3 level logger data for the 2019 season. Based on this correlation, flooding of the subject area occurs following rainfall depths greater than 19-millimetres, with flooding of up to 800-millimetres following rainfall depths greater than 28-millimetres. Calculated depths higher than the measured 800-millimetres were discarded because at high flood levels, prevalence of floodplain storage makes extrapolation unreliable. This is a conservative approach that underestimates the flood contribution to the site following larger rainfall events.

3. Daily rainfall records for a 10-year period were compiled to generate an average yearly rainfall hyetograph in 1-day increments.
4. The 10-year period was assessed to determine the average number, average depth and monthly distribution of rainfall events each year that exceeded the 19-millimetre threshold for flooding.
5. Synthetic "peak rainfall events" were added to the average yearly rainfall hyetograph with temporal spread and magnitudes based on the assessment in step 4.
6. Using an SCS Type III distribution, each daily rainfall event was approximated as a six-hour duration rainfall event hyetograph for each day, occurring mid-day.
7. Hydrologic inputs were calculated based on:
    a) Applying direct rainfall on the subject area;
    b) Applying runoff from the upstream catchment areas using the Modified Rational Method and a 1-hour rainfall intensity as described in the *Iowa Stormwater Management Manual* as level logger data suggests a slight net positive groundwater input following smaller rainfall events.
8. Hydrologic outputs were determined based on:
    a) Applying evapotranspiration using methodology by Thornwaite as described in *Wetland Mitigation: Planning Hydrology, Vegetation and Soils for Constructed Wetlands;*
    b) Calibrating the average infiltration rate for the existing condition (groundwater drawdown) to level logger data observed in the 2019 season (5.0mm/hr);
    c) Releasing surface ponding in the existing condition as water depth recedes (via the existing ditches);
    d) Setting the average infiltration rate for the proposed condition to an average expected rate for clay soil in undisturbed condition (1.5mm/hr) based on level logger data isolated around receding Otter Brook flood events with high ditch water levels;
    e) Setting the average infiltration rate for the winter condition to a reduced rate to represent impermeability of surface frost layers (0.5mm/hr);
    f) Setting the surface ponding release rate to zero when Otter Brook water levels are at or below the top of ditch block and berm levels;
    g) Setting infiltration rates to zero during Otter Brook flood stage;
    h) Groundwater outputs were ignored based on lack of data and the relatively small impact compared to runoff and flooding events.
9. Efficacy of proposed remediation measures were assessed by comparing predicted water levels in the site with and without ditch blocks and site berms.

Following the analysis, ditch block berm elevations were selected to increase the current saturation periods of thirty to eighty hours to a minimum of two weeks during the growing season (June to September) for a representative precipitation year developed above.

Results were also confirmed by assessing performance using the 2013 precipitation records. This year was selected from the period of record because it had a median number (five) large storm events spread evenly throughout the growing season.

Ignoring groundwater inputs on the eastern end of the site and applying infiltration uniformly following recession of high water in Otter Brook is a conservative approach that is expected to result in field measurements of longer and more frequent saturated periods than predicted by the model.

3.3.3 Proposed Restoration

It should be noted that the design of the restoration project is based on the tasks discussed in this section and general knowledge of the conditions present across the Project Site. Design will be adjusted during implementation to accommodate field conditions as necessary and as such, the design may vary from that described in this report.

The proposed restoration activities are to block off the outlets of the approximately 1-metre deep drainage ditches with earthen ditch blocks. The ditch blocks are proposed between 200 millimeters and 300 millimetres higher than the existing top of bank. This will require local grading throughout the site to prevent low areas adjacent to Otter Brook acting as a flow path off the site. This strategy will:

1) Prevent rapid runoff of water volume through the drainage ditches following Otter Brook flood events, retaining it as surface and subsurface saturation;
2) Increase the natural height of the groundwater table in the area by eliminating drawdown from the cut-off ditches throughout the site;
3) Increase the depth and residence time of surface ponding by retaining water on-site with shallow berms tied into local high points in the surrounding topography, and
4) Reduce the groundwater drawdown period (infiltration rate) by eliminating the ditch dewatering path.

The recommended restoration is to install ditch blocks at outfalls to Otter Brook along with localized shallow berms at the site boundaries 200 millimetres to 300 millimetres in height.

3.3.2 Model Results

Figure 2 (below) provides the results of the hydrograph for the Project Site using the average yearly rainfall hyetograph.

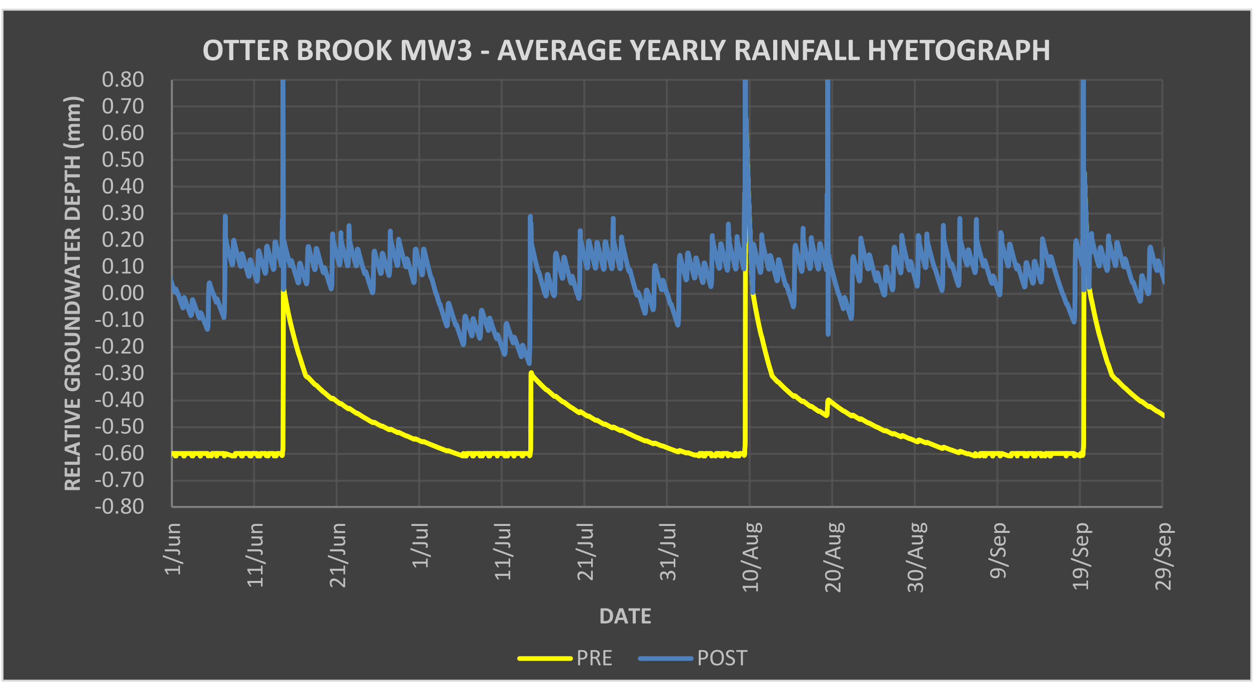


Figure 2: Average Yearly Rainfall Hyetograph

Based on an average yearly rainfall hyetograph, the model predicts water levels higher than 300-millimetres below datum through most of the growing season. However, a limitation of this method is that it spreads rainfall evenly throughout the growing season by averaging daily rainfall events. This does not consider the potential for impacts of extended dry periods during the growing season.

To assess the sensitivity of the system to extended dry periods, the same model was used with actual rainfall data from 2013, selected as a representative median year using the criteria discussed in Section 3.3.2.

Figure 3 (below) provides the results of the hydrograph for the Project Site using the 2013 rainfall hyetograph.

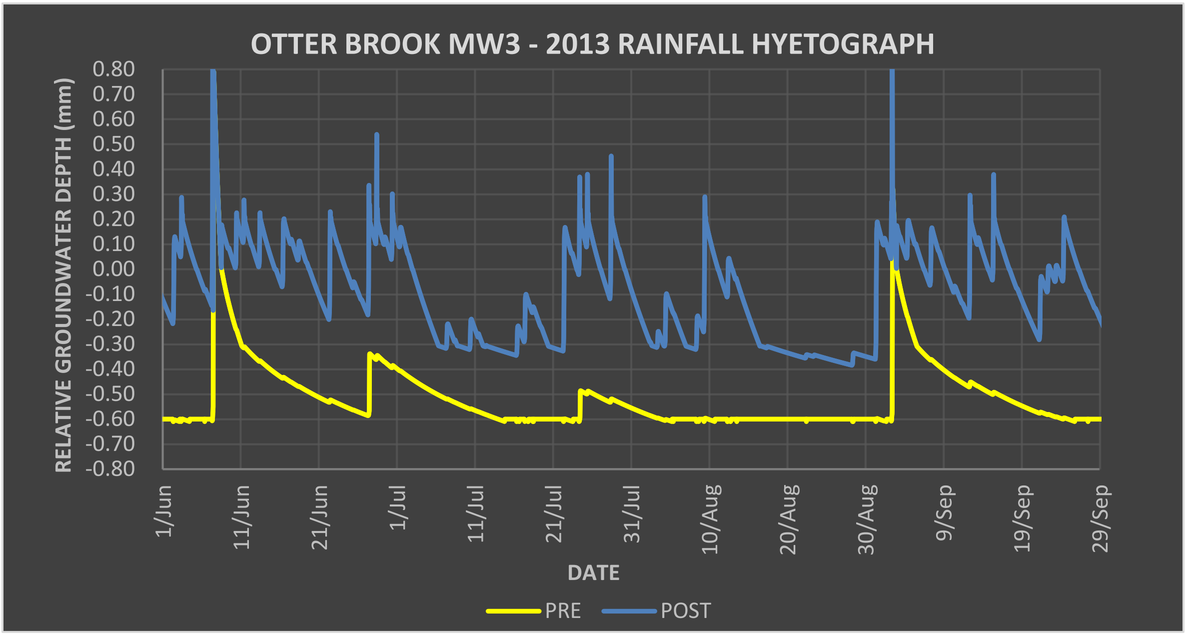


Figure 3: 2013 Rainfall Hyetograph

Extended dry periods reduce the period of ground saturation with the proposed restoration, seen in the lower water levels through July and August. However, with Otter Brook flood inputs and external drainage contribution in the June and September periods, sufficient volume is contributed to the site to meet Project objectives.

<u>3.3.4 Hydrotechnical Recommendations</u>

Based on the preceding analysis, the site will be modified by:

1) Constructing ditch blocks at all existing outflow points. The ditch blocks will have an underdrain installed with a flap gate to allow Otter Brook to flood the site but prevent outflow from the site to Otter Brook, and,
2) Raising the elevation of low points on the site along Otter Brook to maintain surface ponding up to a depth of 300-millimetres above datum before discharge to Otter Brook occurs.

Figure 5 (Appendix A) shows the proposed site with controls installed.

Once proposed restoration structures are installed, the following water level characteristics can be expected across the Project Site based on the hydrograph results and topographical conditions present:

- Ponding on site during spring freshet and periodic Otter Brook flood events will be between 300-millimetres and 800-millimetres in depth;
- Retention time for standing water levels will increase across the Project Site;
- Sub-surface water levels are expected to be higher in the northeastern portion of the Project Site, decreasing to the southwest as a result of increased infiltration gradients closer to Otter Brook; and,
- Intermittent micro low and high areas present across the Project Site will present various depth classes (when water is at surface) and saturation levels (when water is below grade) which will subsequently define the habitat types that succeed.

3.4 Restoration Features and Activities

Based on the conditions discussed above, MEL have designed the restoration project in order to meet the objectives provided in Section 3.1.

The following sections provide a description of the features that are planned for the restoration project. Locations of the features discussed are provided in Figure 5 (Appendix A).

<u>Ditch Diversion</u>

Ditch D2 will be diverted around the eastern edge of the northern berm to maintain hydrological connectivity within D2 from north to south. The diversion channel will lie slightly east of the original ditch and will conduct a source water from the north to the south of the berm. In addition, the diversion channel will be designed to ensure that drainage from the north will continue to split in two directions around the berm - south into D2, and west into D3. A new culvert will be installed to drain water through the new berm.

<u>Ditch Blocks</u>

Ditch blocks will be constructed in all of the existing man-made drainage ditches to prevent free outflow to Otter Brook. A tractor trail will be constructed upon a north-south berm at the north end of the site to prevent flooding of the off-site property (field) to the north. The berm will be constructed to an elevation approximately 1.0 meters above existing grade and taper down in height as it reaches higher grade at the field north of the site and at the forested area west the site. The ditch blocks will be constructed 200-millimetres to 300-millimetres above existing ground at the installation locations. Ditch blocks will be constructed with underdrains and flap gates that will allow inflow from Otter Brook during flood events but prevent outflow following the flood event.

<u>Berms</u>

Shallow berms will be constructed with 10:1 side-slopes to a maximum elevation of 300-millimetres above grade. These berms increase surface ponding retention time following flood events and maximize the potential to retain water volume flowing onto the site from the northern ditch system. Native borrow clay will be used to construct the berm. The organic layer removed during the excavation of ponds will be set aside and used to cover the berms when constructed. This will promote the colonization of vegetation species already growing at the Project Site.

Outflow Structure

Outflow structures are not required. The shallow side-slopes on the constructed berms are designed to allow surface ponding to recede with Otter Brook flood levels with minimal flow depth and velocity over the slopes. Natural vegetation on the 10:1 slopes is sufficient to prevent erosion at the berm locations.

Excavated Ponds

Two excavated ponds will be implemented at the northern and western portions of the Project Site to increase habitat variability. Material from the excavated ponds will be used to build up the north access trail and the shallow berms throughout the Project Site. The ponds will create an intermix of habitat for waterfowl and other wildlife.

4.0 IMPLEMENTATION SCHEDULE

Work is planned to initiate in summer 2020.

A list of tasks proposed for completion, and in order of implementation, is provided below:

- Flag off construction areas and identify access points and equipment routes within Project Site;
- Construction of ponds, shallow berms and northern berm/tractor trail:
- Spread organics on top of berms including native seed base;
- Construction of channel re-diversion and culvert installation (inflow at north);
- Construction of ditch blocks from north to south within ditches;
- Construction of main outflow ditch block and berm. This will be the final activity and involves packing and keying in clay within the drainage ditch and building up the shallow berm upon it; and,
- Site clean up.

Should you have any questions, please don’t hesitate to contact the undersigned.

Sincerely,

Andy Walter (Senior Project Manager)
McCallum Environmental Ltd.
andy@mccallumenvironmental.com
(902) 446-8252 (office) (902) 441-2639 (cell)

5.0 REFERENCES

Keddy, P. A. 2010. Wetland Ecology: Principles and Conservation. New York, New York. Cambridge University Press

Welsch. D., Smart. D, Boyer. J., Minkin. P., Smith, H., McCandless. T. 1995. Functions, Benefits and the Use of Best Management Practices. Accessed from: https://www.na.fs.fed.us/spfo/pubs/n_resource/wetlands/index.htm#Table of Contents

APPENDIX A: FIGURES

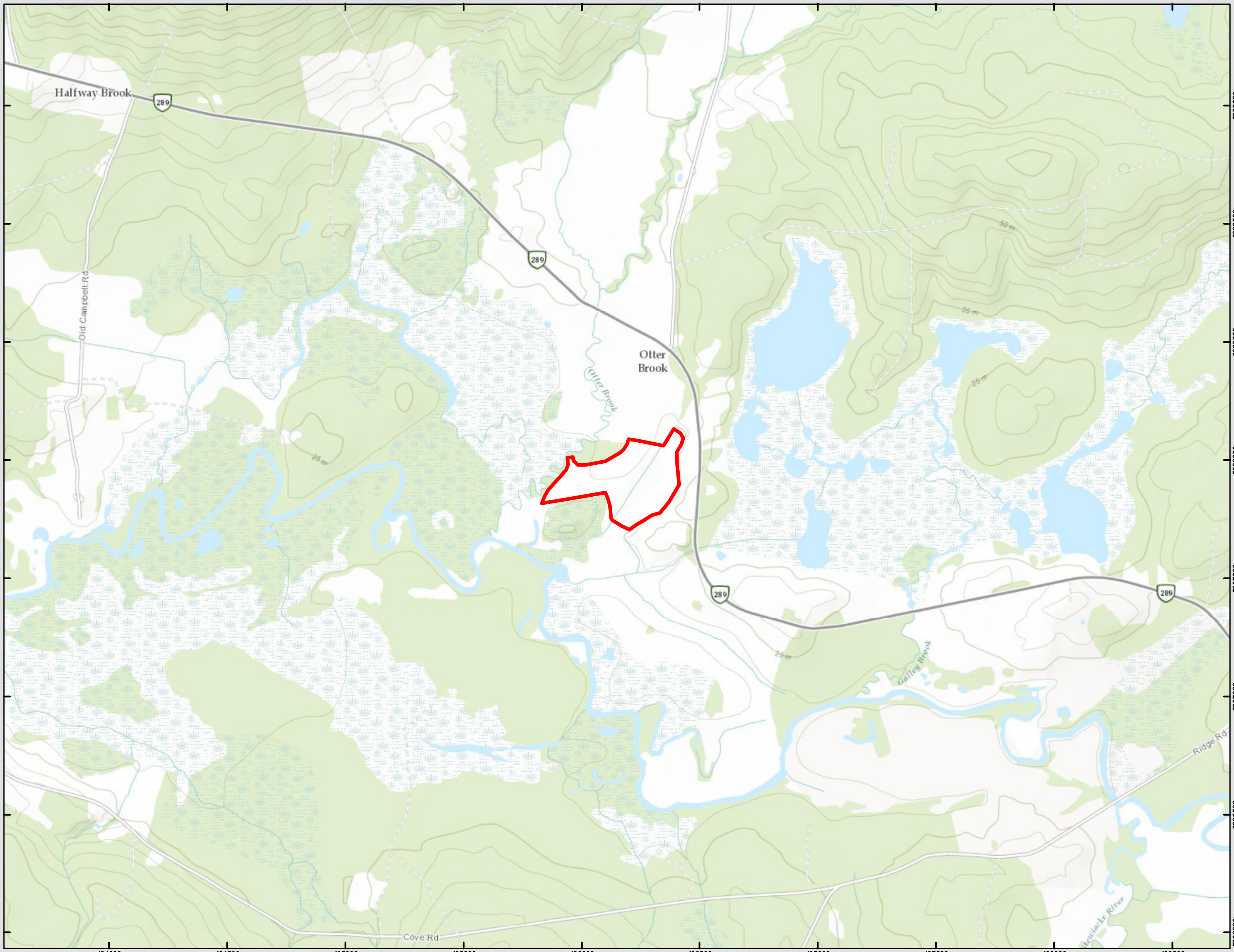
Prepared For:

McCallum Environmental Ltd.

FIGURE 1

Otter Brook Project Site

Otter Brook, NS



Project Site Boundary

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 187.5 375 750 m

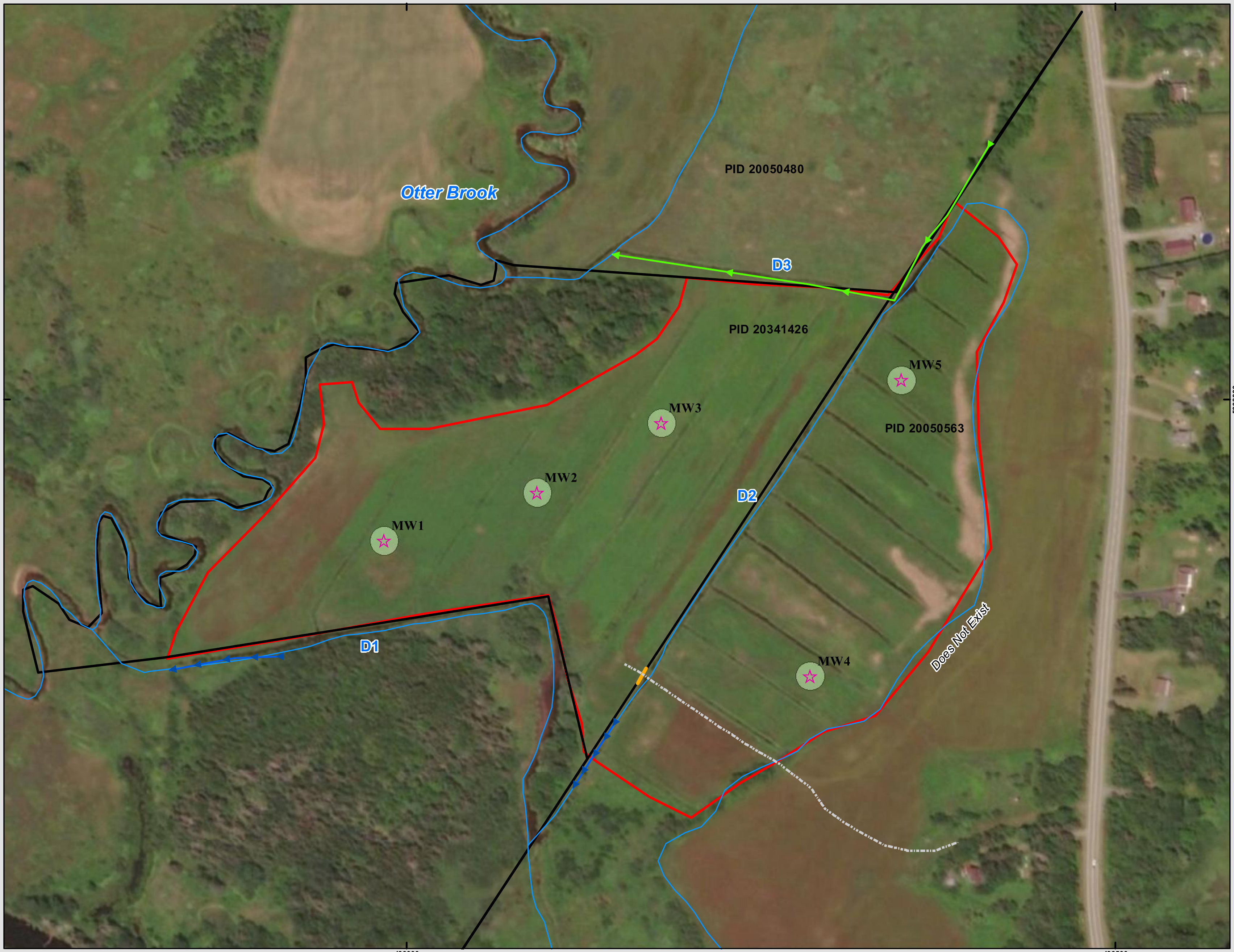
1:15,000 Scale when printed @ 11" x 17"

Drawn By: JRG

Date: 2020-05-13

McCallum Environmental Ltd.

Document Name: 200513_Figure_1_Project_Location



Prepared For:

McCallum Environmental Ltd.

FIGURE 2

Otter Brook Baseline Features

Otter Brook, NS

- Monitoring Well Location
- Tractor Trail (Approximate)
- Culvert
- Ditch
- Flow Direction
- NSTDB Water Line
- Approximate PID boundary
- Project Site Boundary
- Vegetation Assessment Area (1 m radius)

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 30 60 120 m

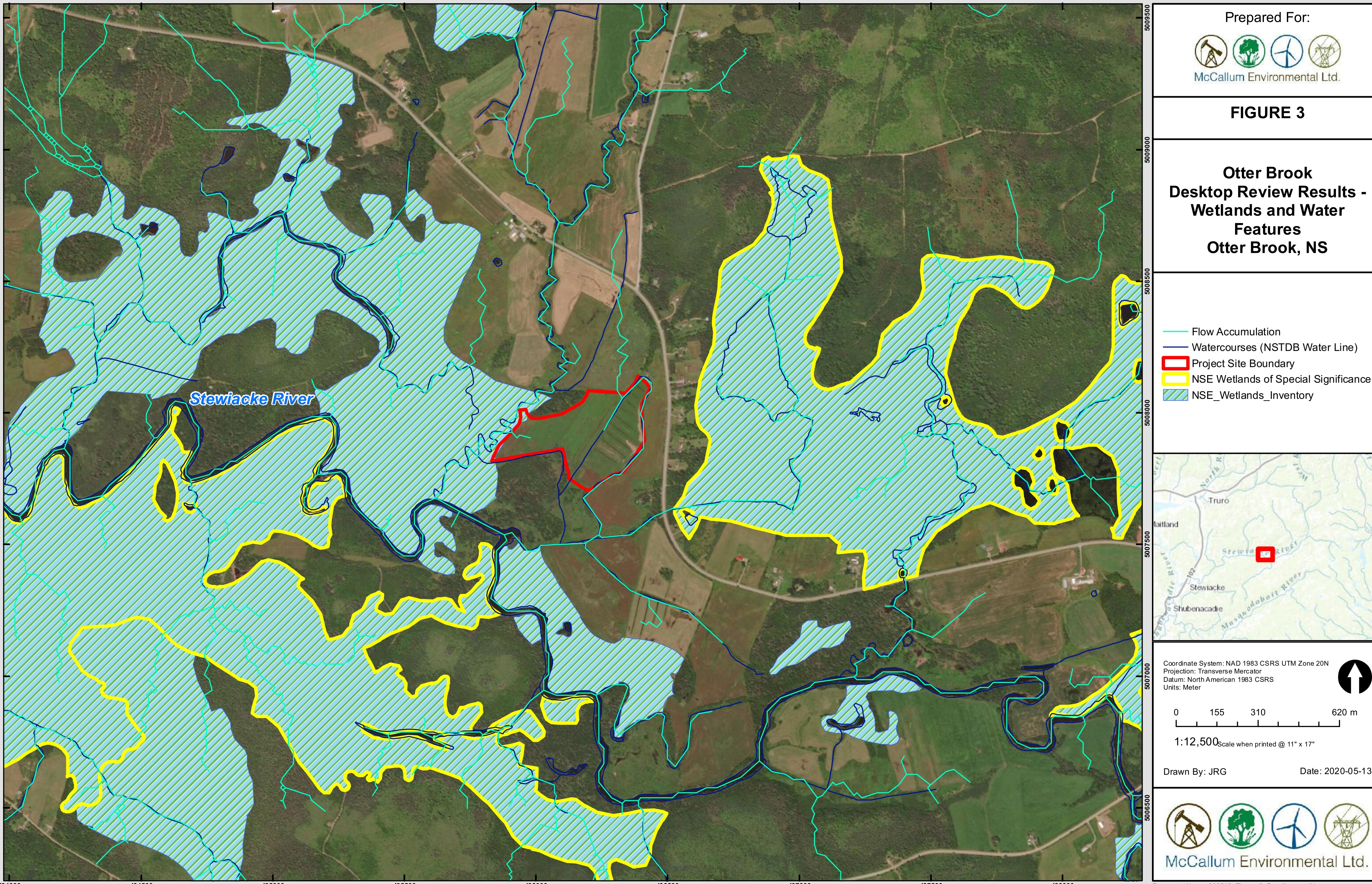
1:2,500 Scale when printed @ 11" x 17"

Drawn By: JRG

Date: 2020-05-14

McCallum Environmental Ltd.

Document Name: 200513_Figure_2_Baseline conditions



Prepared For:

McCallum Environmental Ltd.

FIGURE 3

Otter Brook
Desktop Review Results - Wetlands and Water Features
Otter Brook, NS

- Flow Accumulation
- Watercourses (NSTDB Water Line)
- Project Site Boundary
- NSE Wetlands of Special Significance
- NSE_Wetlands_Inventory

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 155 310 620 m

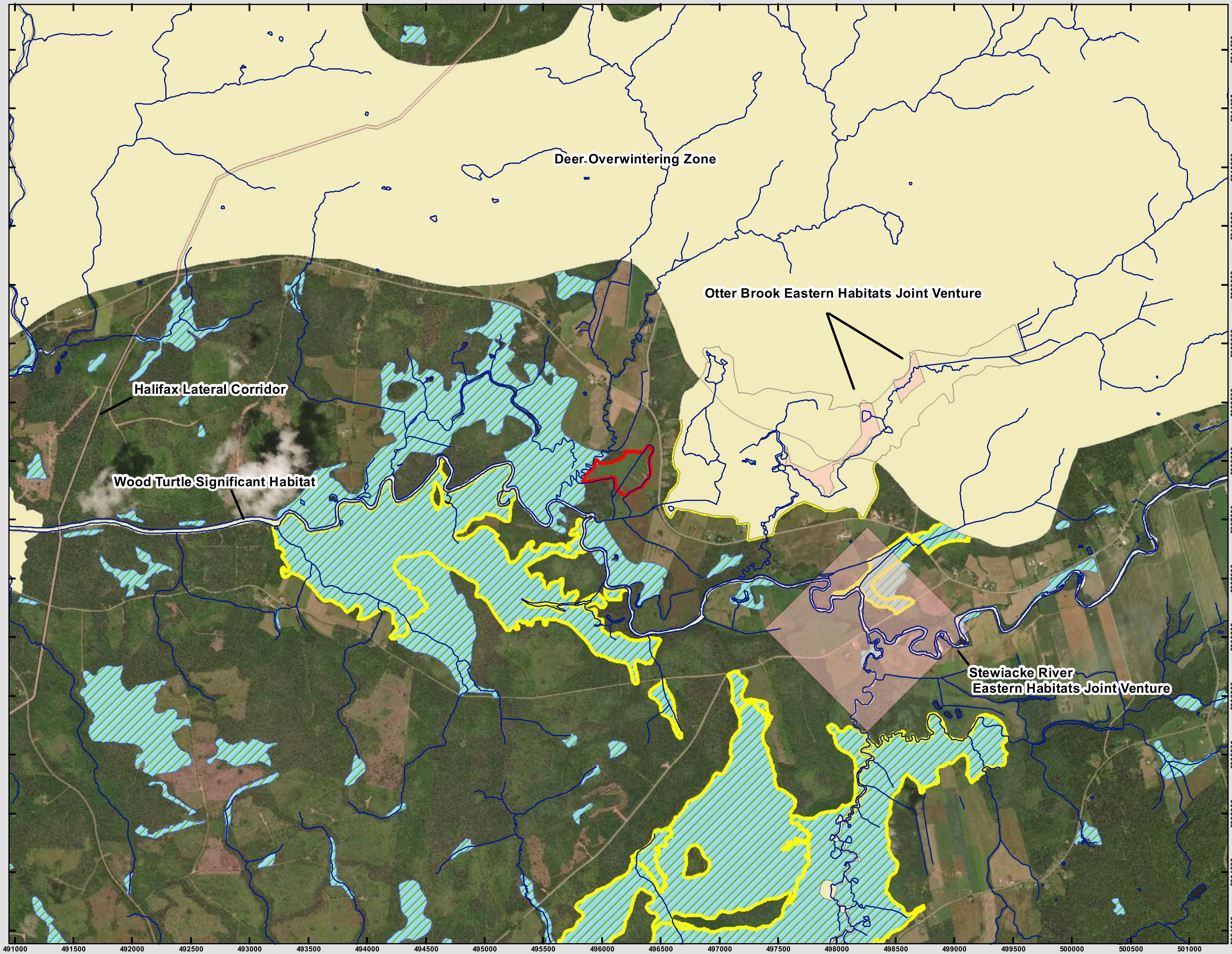
1:12,500 Scale when printed @ 11" x 17"

Drawn By: JRG

Date: 2020-05-13

McCallum Environmental Ltd.

Document Name: 200513_Figure_3_Baseline conditions



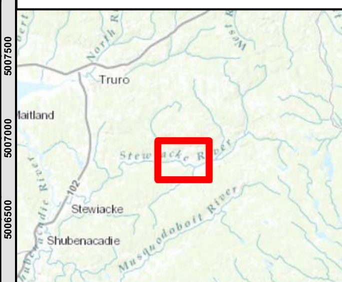
Prepared For:

McCallum Environmental Ltd.

FIGURE 4

Otter Brook Desktop Review Results - Significant Wildlife Habitats and Conservation Areas Otter Brook, NS

- Watercourses (NSTDB Water Line)
- Managed Areas
- Significant Habitat (NSL&F)
- Project Site Boundary
- NSE Wetlands of Special Significance
- NSE_Wetlands_Inventory



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Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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1:30,000 Scale when printed @ 11" x 17"

Drawn By: JRG

Date: 2020-05-13

McCallum Environmental Ltd.

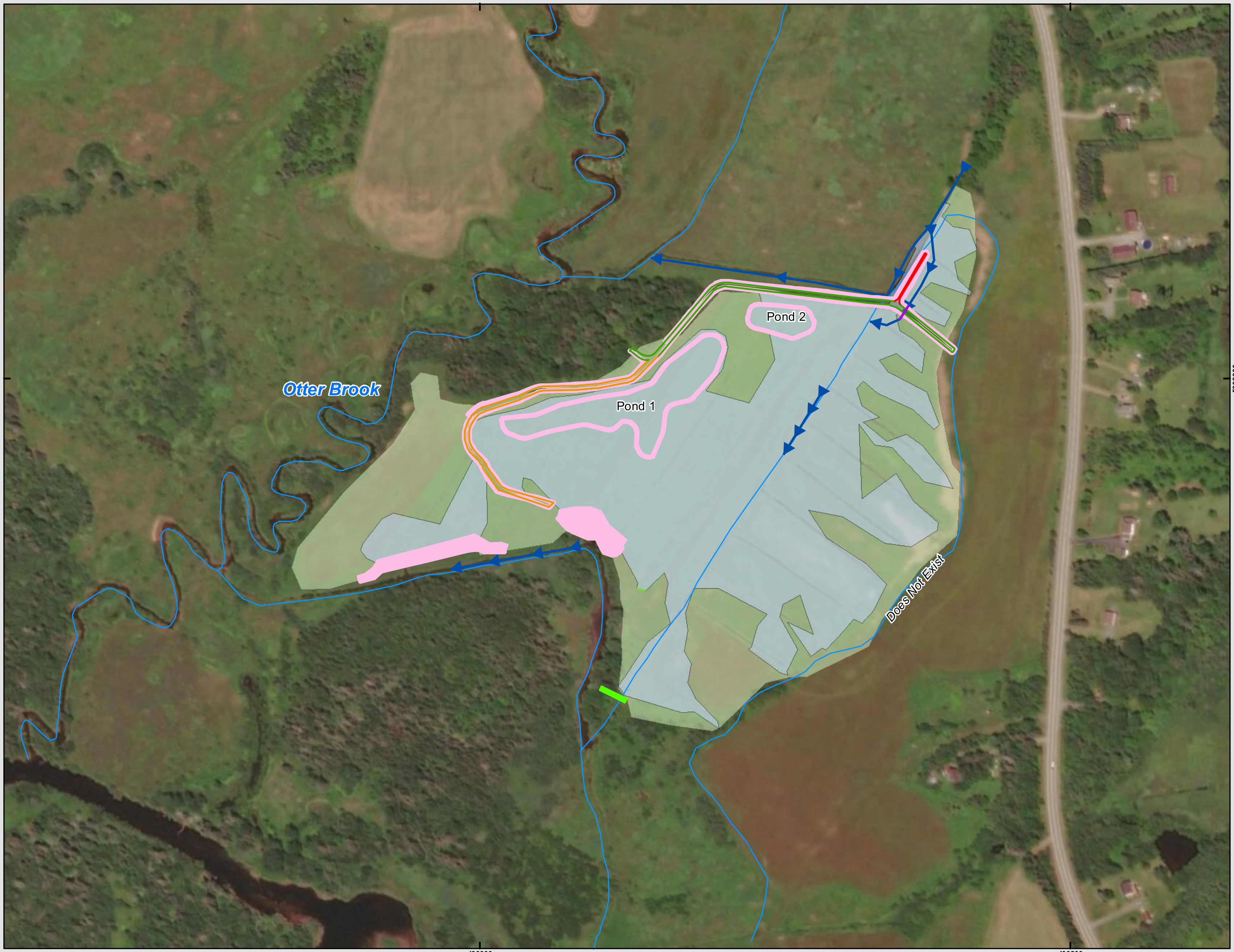
Document Name: 200513_Figure_4_Baseline conditions

Prepared For:

McCallum Environmental Ltd.

FIGURE 5

Otter Brook Proposed Wetland Restoration Design



- Culvert
- Diversion
- Tractor Access
- Walking Access
- Berm
- NSTDB Water Line
- Flow Direction
- Ditch Block
- Approximate Surface Waterline
- Approximate Subsurface Saturation

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 35 70 140 m

1:3,000 Scale when printed @ 11" x 17"

Drawn By: JRG

Date: 2020-05-13

McCallum Environmental Ltd.

Document Name: 200513_Figure_5Final

APPENDIX B: CV'S

Andy Walter, BSc. (Hort)
andy@mccallumenvironmental.com
Senior Project Manager

Years in Practice

10.5 years

Certifications

Nova Scotia Advanced Wetlands Delineator and Evaluator

Memberships

Nova Scotia Wetlands Delineation, Maritime College of Forest Technology

Education

- BSc. (Horticulture), Essex University (UK), 2003-2005

Training

- Wetland Functional Assessment Training Workshop, NSE 2013
- Urban Wetland Restoration: A Watershed Approach, 2012
- Nova Scotia Advanced Wetlands Delineation and Evaluation Course, 2010;
- Water Management and Wetland Restoration Training Course, 2014;
- Identifying and Delineating Wetlands for Nova Scotia, 2009
- Watercourse Alteration Certification (Nova Scotia Environment) (2008)
- Saint John Ambulance Emergency First Aid, AED, CPR(C). 2016

Summary

Mr. Walter is a trained biologist and wetland specialist, and has extensive experience managing technical biophysical projects within Atlantic Canada. Mr. Walter is knowledgeable in federal, provincial, and municipal environmental regulations and guidelines applicable to Atlantic Canada, and works closely with all necessary regulatory agencies to facilitate project implementation. As senior project manager, Mr. Walter ensures biophysical field programs are tailored to the needs of the client and project, while meeting regulatory standards. Mr. Walter has provided environmental support to the planning process in a wide range of project types including residential development, industrial projects (mining, pit and quarry), transmission line and hydro dam infrastructure and highway construction to name a few. Mr. Walter has managed the environmental processes associated with multiple wind energy developments in Nova Scotia, including compilation of provincial environmental assessment (EA) documents, and implementation of associated EA biophysical field surveys, as well as acquiring pertinent environmental information required for regulatory permitting.

As a trained field biologist, Mr. Walter has completed terrestrial and stream habitat assessments, and flora and fauna surveys, including desktop reviews and characterization of biophysical environments. Mr. Walter also completes numerous fish habitat/watercourse assessments for effects monitoring, watercourse alteration, and HADD authorization projects. Assessments have also included water quality sampling, benthic sampling, and biophysical characterization (channel depth and width, stream velocity, fish habitat assessment) of water bodies.

As a qualified wetland delineator and wetland function evaluator for Atlantic Canada, Andy has completed delineation of hundreds of wetlands. Projects often involve the completion of species at risk assessments, functions assessments, and detailed wetland characterization in support of provincial wetland alteration applications. In addition, Mr. Walter assists in the identification of potential wetland restoration and creation sites for wetland and fish habitat alterations, reviews databases, mapping, and aerial imagery, completes ground truthing and consults with local environmental groups and government to identify potential sites. Following alteration approval, Mr. Walter supervises construction activities for numerous construction projects in wetland habitat ensuring that erosion and sedimentation control measures are implemented prior to construction, and monitors activities during construction to ensure wetland protection measures are effective.

Project Experience

- Managing a Provincial Environmental Impact Assessment for a proposed 20MW wind Project in New Brunswick.
- Managing a Provincial Environmental Assessment (baseline surveys, effects assessment and mitigation) for a quarry expansion in Pictou County, NS (2018).
- Managing a Provincial Environmental Assessment (baseline surveys, effects assessment and mitigation) for a quarry expansion in Hants County, NS (2018-2019).
- Managing environmental CEAA screening and associated wetland and watercourse alteration permits for the Paqtnkek Interchange Project for NSTIR (2014-2018).

Andy Walter, BSc. (Hort)
andy@mccallumenvironmental.com
Senior Project Manager

- Managing an environmental screening and associated wetland and watercourse alteration permits for the NSTIR Highway 102/103 Interchange project (2016-2018.
- Managing, and currently in the process of implementing a new wetland functional assessment tool for use in Nova Scotia. This Project included the collection of baseline wetland information across Nova Scotia by completing 120 wetland functional assessments using the Wetland Ecosystem Services Protocol (WESP). Ongoing collaboration with Nova Scotia Environment to support the rolling out of this method to wetland practitioners.
- Management and implementation of a 18 hectare agricultural wetland restoration project in Middle Stewiacke, NS.
- Management and completion of terrestrial habitat mapping, wetland delineation and vegetation surveys in support of EA and regulatory permitting for the South Canoe Wind Project (80MW wind Project in Nova Scotia) 2011-2014.
- Management of a multi-faceted avian study in support of a provincial EA at Aulds Cove, NS.
- Completion of six provincial environmental assessments and baseline surveys for community wind projects in Nova Scotia in 2012-2014.
- Terrestrial habitat mapping, wetland delineation and vegetation surveys in support of a 65km distribution transmission line in central Nova Scotia.
- Wetland delineation, species at risk, watercourses and flora surveys at the site of a proposed quarry in Nova Scotia. Subsequent facilitation of wetland alteration permit to alter in excess of 20 hectares of wetland.
- Implemented the passive wetland restoration strategy at a disturbed wetland on NSDNR property. Completed regular monitoring of vegetation, soil, and hydrology conditions and developed project recommendations accordingly (2009-2011).
- Wetland delineation, species at risk, watercourses and flora surveys at the site of a proposed 22km railway line and shipping container terminal in eastern Nova Scotia (2012-2014).
- Completion of wetland delineation and watercourse identification and associated regulatory permitting at multiple developments in Nova Scotia (2009-2016).

Work Experience

Strum Environmental Services Ltd., Nova Scotia 2008-2015

Environmental Specialist/Project Manager- provided project management expertise for development clients across Atlantic Canada. Projects included environmental assessment, large scale commercial, residential and wind power developments, wetland and watercourse alteration projects, wetland compensation planning and implementation, wetland restoration and creation projects, avian studies, and regulatory consultation.

Amber Stoffer, BSc., MREM
amber@mccallumenvironmental.com

Years in Practice
6

Education

B.Sc. (Honours, Biology), University of Ottawa, 2009-2013.

Master of Resource and Environmental Management, Dalhousie University, 2013-2015.

Training

- Technical Writing Workshop - 2019
- Fish Habitat Assessment - 2019
- Backpack Electrofishing - 2018
- At-Risk Landbird Identification Workshop - 2018
- Fish Habitat Restoration Watercourse Alteration Installer - 2017
- Saint John Ambulance Standard First Aid, AED, CPR(C), 2017
- Marine Emergency Duties – A1, 2014
- W.H.M.I.S – 2013
- PADI Open Water Certified Suba Diver - 2013

Summary

Ms. Stoffer has worked in environmental consulting and research since 2014. She has worked on both project related and research related field assessments in Nova Scotia, Alberta, Quebec.

Ms. Stoffer has a range of experience in biophysical assessments, including flora and fauna surveys, avian surveys, aquatic surveys, wetland delineation, and species at risk evaluations. She has also performed environmental monitoring for a variety of large and small-scale development and exploration initiatives across Nova Scotia. Ms. Stoffer has prepared technical documents for multiple federal and provincial level environmental assessments.

Experience

McCallum Environmental Ltd. - Halifax, Nova Scotia

Junior Environmental Scientist:

July 2017-Present

Completing biophysical assessments, including flora and fauna surveys, with emphasis on fish and species at risk. Completing wetland and watercourse delineations and assessments. Communicating field survey results and methodologies for environmental assessments and other provincial regulatory applications.

Tasks:

- Flora and fauna field surveys
- Species at risk assessments
- Aquatic surveys (electrofishing, fish trapping, benthic invertebrate, periphyton, and sediment sampling)
- Water quality sampling and flow
- Watercourse and wetland identification and assessment
- Wetland delineation
- Construction monitoring
- Communicating field survey results and methodologies for federal and provincial environmental assessments and provincial regulatory applications.

Clean Annapolis River Project – Annapolis Royal, Nova Scotia

Project Leader and Fisheries Technician:

July 2016 – July 2017

Led the planning, coordination, and implementation of fish passage and in-stream restoration work within the Annapolis River watershed. Conducted data collection through field surveys, ecological monitoring, and stakeholder consultation.

Tasks:

- In-stream and culvert restoration

- Fish habitat, water quality, and fish passage assessments
- Watershed management planning
- Staff and student training
- Community and stakeholder engagement

Stantec – Dartmouth, Nova Scotia

Environmental Scientist:

April – September 2014 (Student Contract)

Conducted and coordinated field studies as part of environmental impact assessments, including on-shore and vessel-based marine mammal surveys. Compiled, processed, and analyzed data for technical reports. Developed project work plans and training documents for field surveys.

Tasks:

- Marine mammal population and habitat utilization surveys
- Statistical analysis using R software
- Reporting of methodology and results for environmental assessment

McCallum Environmental Ltd.

John R Gallop, BSc., B.I.T.
john@mccallumenvironmental.com

Years in Practice
5

Education

B.Sc. (Honours, Biology), Waterloo University, 2009-2011.

Training

- Saint John Ambulance Standard First Aid, AED, CPR(C), 2015
- Wildlife Awareness training and ATV training – 2015
- W.H.M.I.S – 2015
- H2S Alive - 2015

Summary

Mr. Gallop has been in the environmental consulting profession since 2011. He has worked on both project related and research related field assessments in Nova Scotia, Alberta and Saskatchewan.

Mr. Gallop is responsible for completing biophysical assessments, including flora and fauna surveys, aquatic surveys (wetlands, watercourses and fish surveys), avian surveys, and species at risk evaluations, primarily for clients in the energy sector, mining sector, and commercial development sector. Mr. Gallop has been responsible for the implementation of 5 environmental baseline programs for mining, quarry development and energy sector development projects in Nova Scotia and Saskatchewan in advance of environmental assessment registration.

Selected Project Experience

- Completion of migratory bird surveys for a large scale renewable energy project.
- Completion of ungulate and other wildlife surveys for a variety of Natural Resource projects.
- Completion of environmental baseline surveys for the federal environmental assessment process for proposed development of two gold mines in eastern Nova Scotia in 2016-2018 across 2500 hectares of landscape in Nova Scotia
  - Wetland delineation and functional assessment
  - Fish habitat surveys and electrofishing
  - Rare plant surveys
  - Wildlife surveys
  - Avian surveys
  - Lichen surveys
- Completion of wetland delineation, watercourse identification and vegetation assessments of two large scale developments in Saskatchewan and Nova Scotia in 2015 and 2016.
- Responsible for collecting baseline data for the calibration of the Wetland Ecosystems Services Protocol (WESP) for the Province of Nova Scotia.

McCallum Environmental Ltd.

John R Gallop, BSc., B.I.T.
john@mccallumenvironmental.com

Experience

McCallum Environmental Ltd., Halifax, Nova Scotia

Biologist and Environmental Specialist:

April 2016-Present

- Completing biophysical assessments, including flora and fauna surveys, with emphasis on species at risk. Completing wetland and watercourse delineations and assessments and coordinating migratory bird monitoring. Communicating field survey results and methodologies for Environmental Assessments and other Provincial regulatory applications.

Basin Environmental LTD., - Edmonton, Alberta.

Environmental Technologist

September 2014 – February 2016..

- Utilized the Alberta Wetland Classification system to assess wetlands and the Wetland Rapid Evaluation Tool to determine compensation required for impacts to classified wetlands.
- Aerially interpreted and delineated wetlands.
- Conducted species at risk background searches and field visits.
- Conducted pre-disturbance assessments for oil and gas activities, road improvements and residential developments, including: watercourses/waterbodies, soil profiling, vegetation, wildlife, eco-sites and timber volumes.
- Prepared reports for a variety of assessments, including: wetlands, pre-disturbance, bio-physicals, fish habitats for access road watercourse crossings, EAP/EFR supplements and applications.
- Monitored the water quality of horizontal directional drilling on fish bearing permanent watercourses.
- Assisted surveyors and construction engineers on-site in the design of oil and gas well leases and facilities, pipelines and access roads to ensure compliance with EAP Standards and Guidelines.

Matt Delorme, P.Eng.

Senior Project Manager

Education

B.A.Sc., Civil/Environmental Engineering, Queen's University, Kingston, Ontario, 1998

Current Professional Affiliations

Association of Professional Engineers of Nova Scotia, #10814
Association of Professional Engineers New Brunswick, #L5511
Engineers and Geoscientists of British Columbia (EGBC), #36479

Volunteer Advisory Positions

Association of Professional Engineers of Nova Scotia Mentor
Immigrant Services Association of Nova Scotia (ISANS) Professional Mentor
Atlantic Infrastructure Management (AIM) Network Technical Committee Member
Paqtnkek First Nation / Municipality of the County of Antigonish Joint Energy Committee Member

Years in Practice

21

Experience Summary

I am a civil/environmental engineer with 21 years' experience in manufacturing, engineering design and project management. Prior to relocating to Nova Scotia in 2015 I was based in Vancouver and have worked on projects in Ontario, BC, Alberta, Northwest Territories and across the Atlantic provinces.

My technical specialty is stormwater management and I have worked on hydrotechnical and detail design for stormwater management facilities (ponds, underground storage and low-impact developments) fish passage culverts across Canada in support of heavy civil infrastructure projects, fisheries compensation areas, in-stream rehabilitation and manufactured wetlands. Having had the opportunity to work on projects from small municipal infrastructure to multi-disciplined engineering design and construction efforts on multi-billion dollar public infrastructure projects, I am familiar with the dynamics of scale on project effort. I strive to find the right balance between performance, budget and client needs in all I do. These projects have required close consultation with a range of stakeholders including First Nations groups, Public Works Canada, Department of Fisheries and Oceans, municipalities and provincial government agencies. I actively seek opportunities to assist with engineering services that support responsible and conscientious infrastructure delivery that is financially, environmentally and socially sustainable.

Selected Project Experience

Wetland Restoration and Compensation, McCallum Environmental, Brookfield, NS (2019 – 2020)
Hydrotechnical design lead responsible for hydrologic and hydraulic analysis to convert agricultural land to engineered wetlands including hydrologic water balances to quantify improvements resulting from . Assisting in GIS and topographical analysis to identify potential restoration areas in Nova Scotia. Detail design of a berm repair and overflow weir for a constructed wetland.

Surrey Langley Skytrain Project, Translink, Metro Vancouver, BC (2019-2020)
Stormwater lead for Owner's Engineer services responsible for developing a reference concept design for a new Skytrain and road expansion corridor in Metro Vancouver. Responsible for developing technical requirements for the Design Build Contract and writing the stormwater management Project Agreement requirements.

Tłı̨chǫ All Season Highway Design Build, Government of the Northwest Territories, NWT (2019 – 2020)
Currently design lead for detail design of roadway drainage, cross culverts, fish passage culverts and equalization culverts on behalf of North Star Infrastructure, the successful public private partnership (P3) proponent constructing a 100-kilometer greenfield highway development. Responsible for quality control of the design process, training and mentoring junior and intermediate engineering staff and participating in quality and process audits for design. Duties include managing the drainage team budget, justifying change orders for additional work requested by the contractor and responding to Owner comments and information requests. Design required assessment the effects of climate change on hydrologic response of drainage basins resulting from increased precipitation, changes in permafrost distribution, increased probability of forest fires and changes in the snow/rain regime in winter months. Design is scheduled to be completed in 2019 with construction complete in 2021.

Bayside Travel Center, Paqtnkek First Nation, Afton Station, NS, Project Manager. (2017 – 2020)
Project Manager and lead civil engineer for a $12,000,000 retail/commercial gas station, restaurant, truck stop and entertainment center. Responsible for management of the interdisciplinary design team, client reporting on schedule and budget and liaising with the Construction Manager and Architect. Project required monthly updates to Band Council and Indigenous Service Canada (ISC) on the $12,000,000 budget. As lead Civil Engineer on the project, I oversaw water treatment plant design, sanitary treatment design, utility infrastructure, environmental permitting and reviews with Indigenous Services of Canada.

George Massey Tunnel Replacement Project Bid Design, Ministry of Transportation, Metro Vancouver, BC (2016 – 2017)
Drainage and stormwater design lead, responsible for team coordination and development of a concept design in support of a construction bid estimate for the $3.5 billion bridge replacement of the George Massey Tunnel and upgrades to 24 kilometers of highway. Stormwater management and treatment was a key component of the design which was in low lying, diked municipalities with average elevation below high tide. Design took into consideration changing sea level boundary conditions at pump stations and increased frequency and volume of rainfall from climate change. Property restrictions and budget limitations required a variety of stormwater storage facilities to prevent increases in water levels in existing systems. The water quality philosophy was based on naturalized systems of bioswales and wetlands to treat road runoff and bridge runoff containing de-icing fluids without cumbersome and costly hard infrastructure.

Highway 104 Paq'tnkek Interchange, NSTIR, Antigonish, NS (2015 – 2018)
Drainage and environmental design lead responsible for hydraulic design, detail design specifications and cost estimates for fish passage culverts, channel realignments and erosion and sediment control plans. Responsible for coordination of and collaboration with environmental subconsultant to prepare CEAA, Watercourse and Wetland Alteration applications.

Halifax Shipyard Modernization Program, Irving Shipbuilding Inc., Halifax, NS (2015)
Municipal Engineer responsible for site grading, stormwater design, sanitary service design and water service relocation for a proposed security building.

George Massey Tunnel Replacement Project, BC Ministry of Transportation, Metro Vancouver, BC (2014)
Owner's Engineer and Design Discipline Lead, responsible for a stormwater management reference concept design and report as Owner's Engineer for a new bridge construction and highway expansion in low lying, diked municipalities along the Fraser River. The report assisted in project planning, assessing property requirements and assembling the request for proposals. Also responsible for writing drainage and stormwater management design criteria for the public private partnership contract documents which sought to accommodate multiple stakeholders with competing and sometimes conflicting requirements.

Port Mann Pump Station Fish Friendly Upgrades, Transportation Investment Corporation, Coquitlam, BC (2013 – 2014)
Project Manager, responsible for managing multi-discipline design team for fish friendly upgrades to the Port Mann Stormwater Pump Station design build project.

Port Mann Bridge/Highway 1 (PMH1) Upgrades, BCMOT, Various Municipalities, BC (2008 – 2014)
Various responsibilities over a six-year delivery of the largest design-build project in BC history to expand 36 kilometers of Highway 1 through dense urban areas, upgrade 11 interchanges and replace over 30 culverts with fish passable channel crossings.

- **PMH1 Project-Culvert Design, Transportation Investment Corporation, Various Municipalities, BC**
  Project Engineer, responsible for generating SWMHYMO and PCSWMM hydrologic and hydraulic models to assess existing culverts and design proposed rehabilitations and upgrades that met contractual, environmental and regulatory commitments.

- **PMH1 Project-Storm Sewer Rehabilitation Management, Transportation Investment Corporation, Various Municipalities, BC**
  Project Engineer, responsible for reviewing storm condition assessment and proposed rehabilitation measures including slip-lining, patching and spot replacement to assist design build contractor in executing the most cost-effective rehabilitation plan.

- **PMH1 Fish Compensation and Culvert Upgrades, Transportation Investment Corporation, Various Municipalities, BC**
  Project Engineer, responsible for creating hydrologic event models to estimate stream flow in fisheries sensitive streams. Analysed flows using HEC-RAS and HY-8 to optimize hydraulic performance of fish-passage culverts and to design hydraulic structures for fisheries compensation areas. Designed natural channels beneath the highway to promote fish and wildlife migration. Collaborated with environmental professionals to design channel tie-ins and replace or enhance aquatic habitat. Analysed hydraulic data and assessed site conditions to design scour pools, channel linings, bank erosion protection and channel realignments for highway stream crossings. Provided field instruction to assist construction crews with construction of complex fisheries design features.

Bridgeport Bus Loop, Translink, Richmond, BC (2008)
Project Engineer, responsible for preparing detail drainage design specifications for a proposed bus loop including lot grading to optimize surface storage of major flows that eliminated the need for costly underground storage systems.

Sea-To-Sky Highway, BC Ministry of Transportation, Squamish, BC (2008-2009)
Project Engineer, responsible for hydraulic calculations and detail design for highway infrastructure including a drainage pump station, storm sewers, culverts and open channels.

Douglas Border Crossing, Public Works Canada, Delta, BC (2008-2009)
Project Engineer, responsible for compiling civil engineering-related LEED certification documents. Provided third party review of erosion and sediment control reports and performed stormwater management calculations for LEED certification.

Davidson Molybdenum Project, Blue Pearl Mining Ltd., Smithers, BC (2007)
Project Engineer, responsible for designing an HDPE pipeline and steel multiport diffuser to safely discharge treated mine effluent to the Bulkley River within regulatory limits. Adapted EPANET water system hydraulic software to model the system performance.

Galore Creek Mine Erosion and Sediment Control Program, NovaGold Resources, Bob Quinn, BC (2007)
Environmental Engineer, responsible for developing erosion and sediment control plans for construction operations and authoring permit applications to submit to Ministry of the Environment. Also generated hydraulic design of run off channels, sewers, culverts, and detention ponds for stormwater treatment, conveyance and sediment control during construction operations.

APPENDIX C: PHOTOLOG

Photo 1: D2 (August 9, 2018).

Photo 2: D3 (August 9, 2018).

Photo 3: D2 (July 3, 2019).

Photo 4: Trail crossing D2 (flooded, July 3, 2019).

Photo 5: Culvert beneath D2 trail crossing (July 3, 2019).

Photo 6: D3 (July 3, 2019).

Photo 7: Northern drainage into D2/D3 (July 3, 2019).

Photo 8: Otter Brook/D3 confluence (July 3, 2019).

Photo 9: D1 (July 3, 2019).

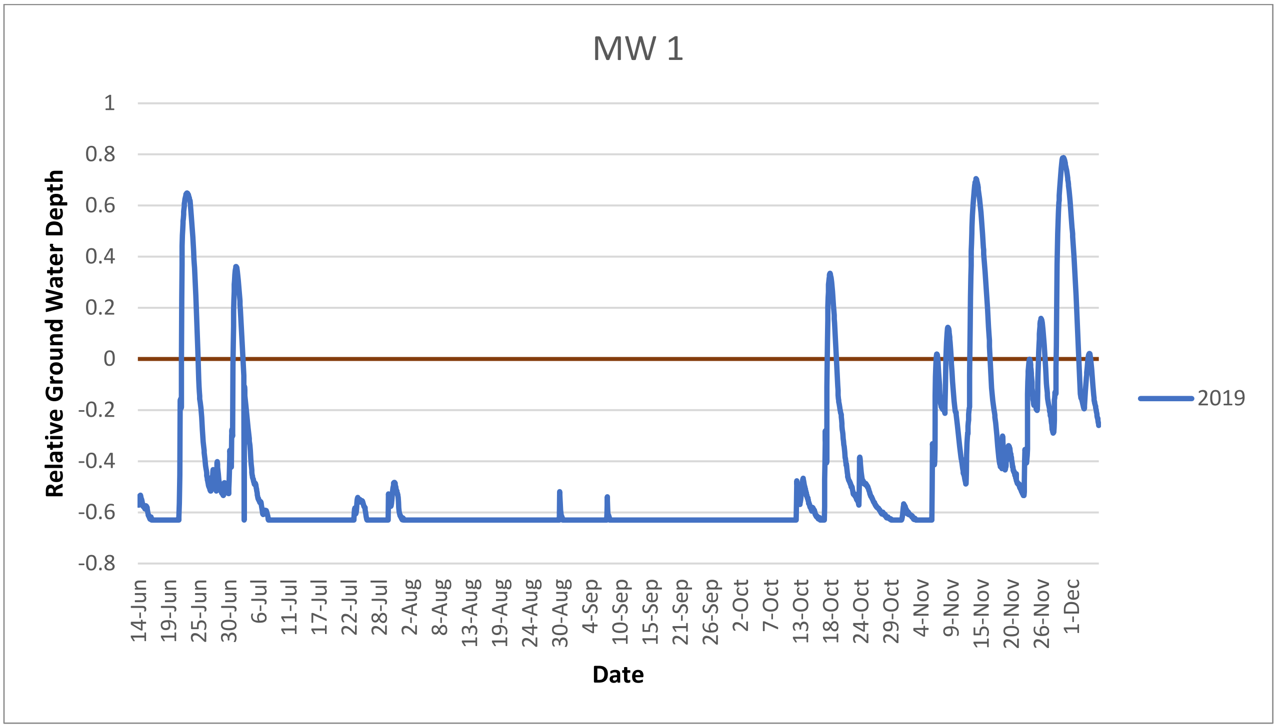
Photo 10: Otter Brook/D1 confluence (July 3, 2019).

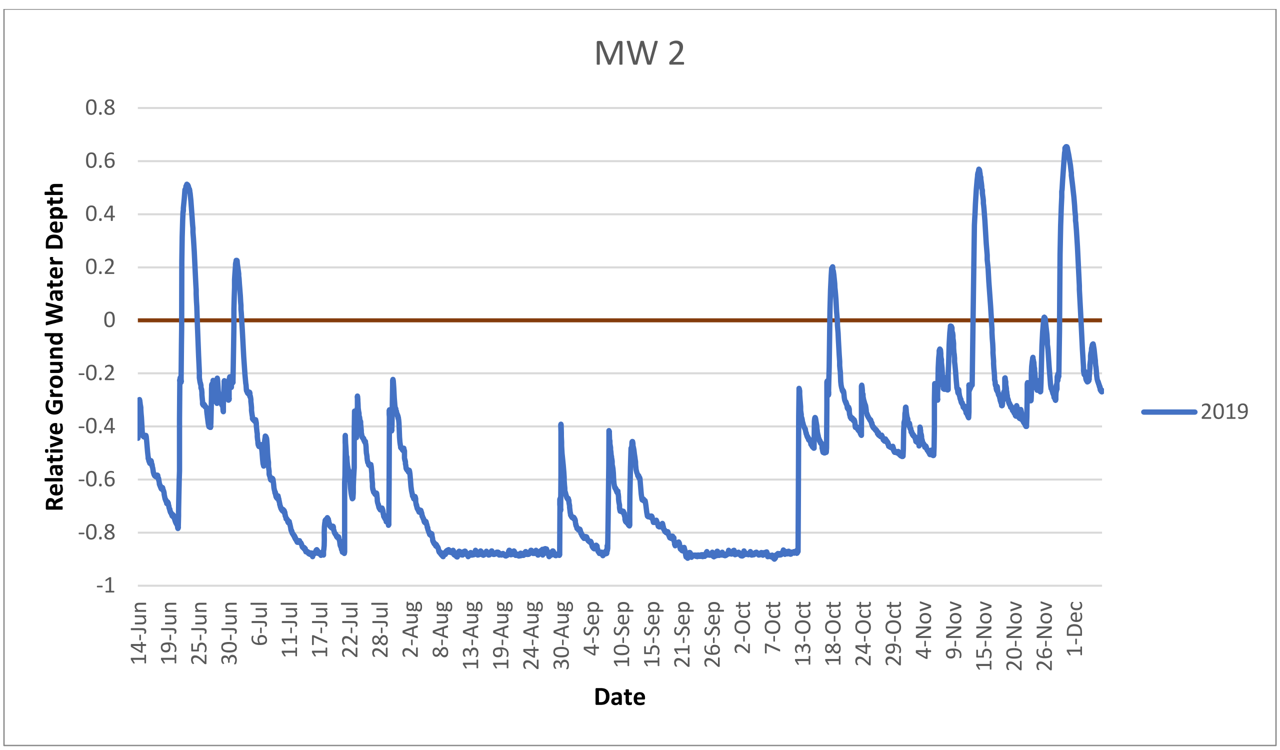
Photo 11: Wetland Restoration Project Site Looking Southwest – D2 indicated with arrow

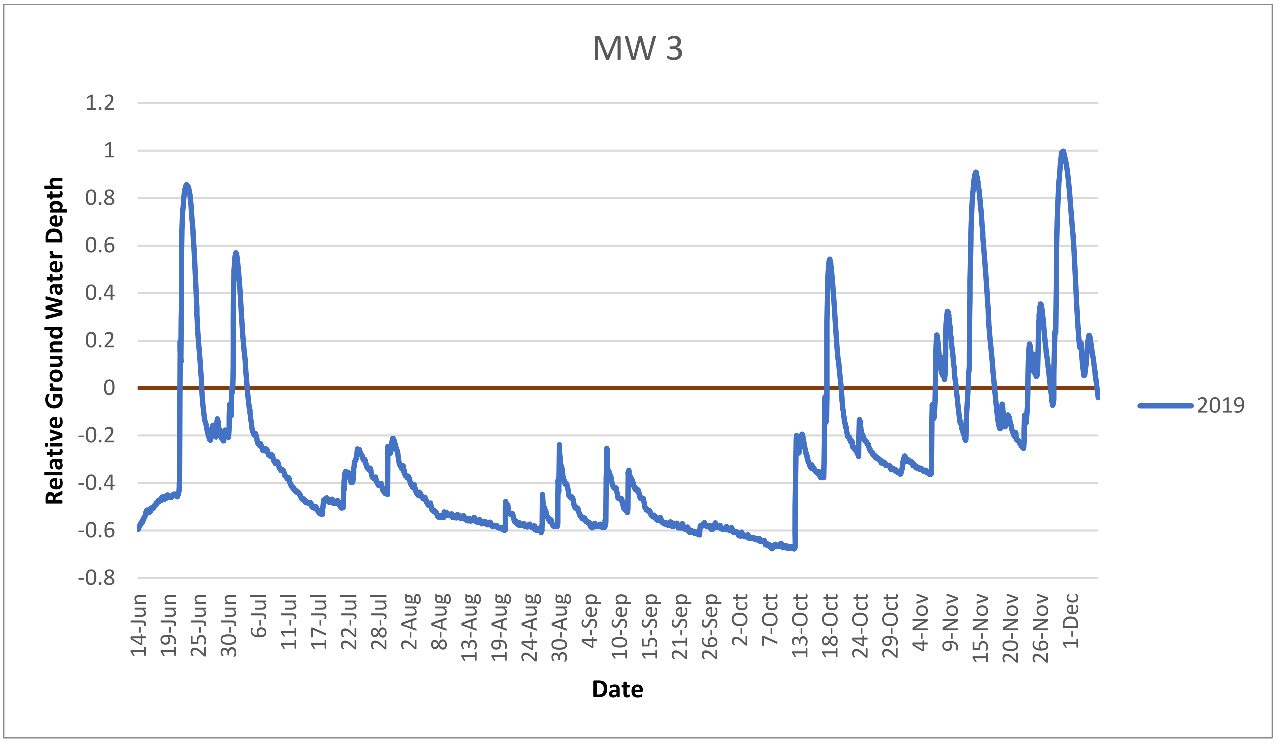
McCallum Environmental Ltd.

APPENDIX D: HYDROGRAPHS

McCallum Environmental Ltd.






MW 3
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Relative Ground Water Depth
14-Jun
19-Jun
25-Jun
30-Jun
6-Jul
11-Jul
17-Jul
22-Jul
28-Jul
2-Aug
8-Aug
13-Aug
19-Aug
24-Aug
30-Aug
4-Sep
10-Sep
15-Sep
21-Sep
26-Sep
2-Oct
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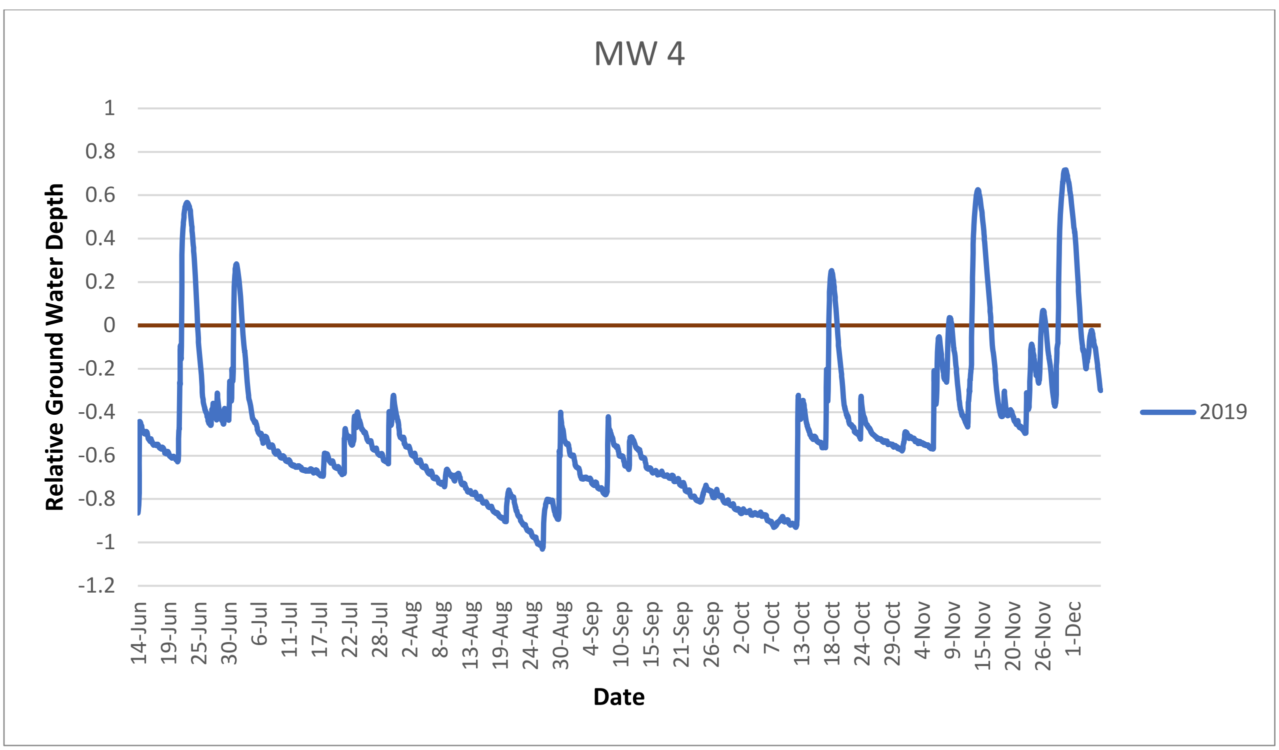
26-Nov
1-Dec
Date
2019


MW 4
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
Relative Ground Water Depth
14-Jun
19-Jun
25-Jun
30-Jun
6-Jul
11-Jul
17-Jul
22-Jul
28-Jul
2-Aug
8-Aug
13-Aug
19-Aug
24-Aug
30-Aug
4-Sep
10-Sep
15-Sep
21-Sep
26-Sep
2-Oct
7-Oct
13-Oct
18-Oct
24-Oct
29-Oct
4-Nov
9-Nov
15-Nov
20-Nov
26-Nov
1-Dec
Date
2019

McCallum Environmental Ltd.

APPENDIX B: Wetland Mesocosms Research Study Documents

NOVA SCOTIA
Environment

Barrington Place, Suite 2085
1903 Barrington Street,
PO Box 442
Halifax, Nova Scotia
Canada B3J 2P8

902-499-6086t
902-424-6925f
novascotia.ca

July 31, 2020

Mr. Jim Millard
Atlantic Mining NS Corp
409 Billybell Way, Mooseland
Middle Musquodoboit, Nova Scotia
B0N 1X0

By email to: James.Millard@atlanticgold.ca

Dear Jim:

Re: Letter of Support for NS Legacy Gold Mine Wetland Remediation Project

The NSE Wetlands Program has reviewed the proposal for the Project entitled "Developing an in-situ risk management strategy for enhancing natural recovery of highly contaminated gold mine tailing impacted wetlands" originally proposed by St. Mary's University's Dr. Linda Campbell and John Brazner of NS Lands and Forestry.

Based on the letter of financial support submitted by Atlantic Mining NS Corp on November 22 2019, and the signed Letter of Understanding (LOU) submitted on July 16 2020, I am confirming acceptance as a form of compensation relating to approved wetland alterations at the Touquoy Gold Mine.

The project will be equivalent to a compensation credit of \$3/m^2 for up to 35 hectares (or a total of \$210,000 per year for a period of 5 years, 2020-2024). The proposed project is a component of the overall wetland compensation plan associated with wetland alterations at the Touquoy Gold Mine. It is Atlantic Mining NS Corp's responsibility to ensure that a minimum of 50% of their compensation obligations are completed as on-the-ground projects. The project will be designed and undertaken by St. Mary's University Environmental Sciences researchers and NS Lands and Forestry staff with the results, conclusions and recommendations being provided to Nova Scotia Environment.

The referenced study supports development of a "Made in Nova Scotia" approach to remediation of wetlands impacted by legacy gold mine tailings and further understanding of bioaccumulation of associated contaminants on migratory bird species. This project intends to:

- Assess ecotoxicology and bioaccumulation of contaminants from wetland sediments impacted by gold mine tailings in multi-species community systems; and
- Assess feasibility of in-situ bioremediation of two low-dose additives to reduce toxicity of sediments.

The project supports the NS *Wetland Conservation Policy* by evaluating the environmental impacts of legacy gold mine sites, identifying potential compensation sites in the future, as well as furthering knowledge related to the use of wetlands by migratory bird species and explores the use of emergent aquatic insects as a monitoring/bio-sentinel species to assess ecosystem impacts and risks.

We look forward to seeing the results of this innovative research initiative. Please contact the undersigned with any questions.

Sincerely,

Ian Bryson M.Sc., EP
Wetland and Water Resources Specialist
Nova Scotia Environment
(902) 719-5173
Ian.bryson@novascotia.ca

CC:
Dr. Linda Campbell, Environmental Sciences, St. Mary's University
Dr. John Brazner, Ecosystem and Habitat Specialist, NS Lands and Forestry
Andy Walter, Sr. Project Manager, McCallum Environmental Ltd.
Elizabeth Kennedy, Director, NSE Water Branch
Jennifer Rocard, Manager, NSE Water Resource Management Unit
Rachel Bower, Inspector, NSE Inspection Compliance and Enforcement
Emma Kinley, Wetland and Water Resources Specialist, NSE Water Branch

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March 26, 2021

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2021 Letter of Understanding for Wetland Compensation for the Touquoy Gold Mine Project

Dear Mr. Merkley

This is a *letter of understanding* ("LOU") made as of March 30, 2021 between:

Atlantic Mining NS Corp. ("the Proponent")

-AND-

Saint Mary's University ("SMU")

The Proponent and SMU have agreed to collaborate in the implementation of a proposed research study as further detailed in a collaborative research agreement between the Proponent and SMU.

The research study entitled *"Developing an in-situ risk management strategy for enhancing natural recovery of highly contaminated gold mine tailing impacted wetlands"* ("Project") will be partially financed by the Proponent as a method of Secondary Wetland Compensation for the Touquoy Gold Mine Project.

The Proponent initiated financial contribution to SMU in 2020 and has committed to future financial commitments on an annual basis for an additional four years (2021, 2022, 2023 and 2024), provided the Project has not been terminated. Annual contributions to the study will be up to a maximum of $210,000 per year with an associated wetland compensation credit of $3 per m^2 as agreed to with NSE. An annual LOU will be provided to NSE on or before March 31 outlining the financial contribution and associated wetland compensation credit for the forthcoming year.

The Proponent and SMU (as applicable) will keep NSE informed of the Project progress via an annual report.

SIGNED as of the date set forth above.

Digitally signed by Adam Sarty
Date: 2021.03.30 12:24:53 -03'00'

Dr. Adam Sarty
Associate Vice President, Research

Saint Mary's University
923 Robie Street
Halifax, Nova Scotia
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James Millard
Manager Environment and Permitting

Atlantic Mining NS Corporation
6749 Moose River Rd,
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Sincerely,

James Millard
Manager Environment and Permitting
Atlantic Mining NS Corporation

Cell (902) 403-1337
Email: james.millard@atlanticgold.ca

cc ***

Danielle Finlayson - Atlantic Mining NS Corporation

Melissa Nicholson - Atlantic Mining NS Corporation

Developing an in-situ risk management strategy for enhancing natural recovery of highly contaminated gold mine tailing impacted wetlands

The purpose of this document is to provide Nova Scotia Department of Environment information on the progress of this project as part of AMNS' wetland compensation plan. The document outlines progress towards deliveries, and summarizes activities completed in 2020. A list of activities planned for 2021 has also been included.

Project Background:

Late-1800's gold mining practices in Nova Scotia has led to serious mercury (Hg) and arsenic (As) contamination of wetlands and shallow freshwater environments across the Province, potentially impairing ecological functions of these wetlands. Environmental risks and financial liability associated with this unresolved issue are high. There are potentially over 300 wetland areas within 64 abandoned gold mining districts. Just within the Montague gold mining district, it has been estimated that there are at least 10 hectares of impacted wetlands. Wetland and shallow-water settings are particularly challenging for remediation and risk management. Removal of contaminated sediments is disruptive and can re-mobilize contaminants. Physically isolating contaminated sediment using thick 'capping' layers of sand and clay would lead to a net loss of wetland ecosystems for the Province and would also require expensive compensation requirements. Cost-effective remediation strategies that can be used at the wetland sites to manage the risk of both As and Hg, and that can also ensure that wetland characteristics are retained and improved would be most promising. The overall objective of this project is to develop an innovative, safe, and cost-effective risk management strategy for highly contaminated legacy gold mine waste in wetlands. This strategy will be developed in collaboration between SMU and Atlantic Mining Nova Scotia Inc. If successful, this reactive amendment application will cost-effectively support the integrity and natural-functioning of wetlands, reclaim potentially-valuable waterfront property sites, as well as improve remote sites for recreation, tourism, fishing, hunting and shellfish harvesting.

Timing and progress towards milestones/deliveries

This 5-year project "*Developing an in-situ risk management strategy for enhancing natural recovery of highly contaminated gold mine tailing impacted wetlands*" was initiated in August 2020 and is progressing well and on schedule. Since the project start date, monthly meetings have been held between AMNS and SMU and two quarterly reports have been prepared for the project outlining work/progress to date. These reports were delivered to AMNS for review in October 2020, and January 2021.

Summary of work completed between August-December 2020:

Hiring/recruitment of key personnel:

- Research Project Manager Dr. Emily Chapman was hired in this role and completed "onboarding" with SMU in August.
- Technician/intern position**:** A total of 52 applications were reviewed in relation to the technician/intern position. The interviews were completed over 3 days (September 21-23). The successful candidate started with us on October 13.

- Student recruitment: Dr. Campbell and Dr. Chapman interviewed potential PhD and MSc students and investigated funding options for potential interested students to join the team.

Completion of NSERC Alliance Application:

- The month of August and most of September was spent developing the National Sciences and Engineering Research Council (NSERC) Alliance application with Atlantic Mining Nova Scotia (AMNS) and McCallum Environmental Ltd (MEL) as partners. These grants support research projects led by complementary, collaborative teams that will generate new knowledge and accelerate the application of research results to create benefits for Canada. Due to a submission error, this application was not submitted until January 2021, but is currently being reviewed by NSERC. NSERC's review of the application will take between 12-16 weeks, so a decision on funding is now expected by mid-May 2021.

Invertebrate Cultures Start up and Maintenance:
During the fall of 2020 we established 5 thriving cultures in the laboratory. Invertebrate, and algae cultures will be used for mixed mesocosm ecotoxicity and bioaccumulation testing later in 2021. Below we list the cultures and their purpose, and the status.

Table 1. Summary of progress with culture set-up

Species	Purpose	Culture status	SOP status	Experimental readiness
Hyalella (*Hyalella azteca*)	Sediment ecotoxicity testing	Mixed cultures at SMU sorted (November 2020). Known-age cohort cultures established (November 2020)	SOP is completed.	Close. Need more juveniles. Water hardness issues being troubleshooted.
Amano shrimp (*Caridina multidentata*)	Hg & As bioaccumulation	Obtained from Aquarica Tropical Fish in Bedford (November 2020)	SOP and logsheets being developed.	Ready. We may need to purchase more prior to experiments as some were lost during acclimatization.
Miniature crayfish (*Cambarellus patzcuarensis*)	Hg and As bioaccumulation	Obtained from Angelfins, ON (November 2020). Survived 3-day courier delay. Juveniles being produced.	SOP and logsheets completed.	Close. Need fully matured adults. (6-8 weeks)
Daphnia (*Daphnia magna*)	Water ecotoxicity testing	Obtained from Harris Industrial Testing (Waverly) (December 2020)	SOP being finalized.	Not yet. Need time for culture to be established and for juveniles to be produced.
Green algae *(Chlorella kesslerii)*	Algal food for invertebrates (Photo 2)	Obtained from U of Waterloo (November 2020). Stock cultures stablished (December 2020)	SOP finalized	Ready.
Dragonfly nymphs	Hg and As bioaccumulation	Pending. Research is underway on collection, culture and maintenance.	Pending.	Not yet.

Experimental Laboratory Work:

- During the first part of November 2020, we worked on setting up a laboratory space for amendment experiments. This included rearranging laboratory layout as well as organization of equipment and supplies.
- Researched alternative less expensive amendment materials appropriate for field applications, based on the successful laboratory-grade materials we used in our pilot experiment.
- Completed an "Amendment Processing Test". In November/December 2020 we assessed reactive slurries/capping materials used in the pilot test - how slurries adhere to/dries to inert carrier materials and how each material (slurries and dried material) sinks/dissolves in water

Development of Experimental Design for Amendment Adsorption Capacity Tests:

To determine reactivity and Hg and As adsorption capacity of materials and different blends/processing options, a 2-phased test was developed for execution in 2021 with the following 3 objectives (a) test various combinations of reactive compounds, ingredients and carrier matrices and determine the effectiveness of each type of reactive amendment ingredient for adsorbing As and Hg in water; (b) assess how adsorption of Hg and As may be impacted by pre-application processing (e.g. preparation of each type of reactive slurry, drying of reactive amendment ingredients and types of carrier materials), and (c) determine the most cost effective reactive amendment dose for maximum adsorption of As and Hg from contaminated sediments. It is anticipated that the results from this 2-phased experiment will aid in the selection of the most cost-effective amendment blends for future more extensive testing using mixed-species mesocosms with live organisms.

Public communications and outreach:

AMNS and SMU communication officers and the DEEHR research team met several times to discuss media communication strategies and we have drafted a media release. Currently, the draft is awaiting reviews and approvals from Santa Barbara Ltd in Australia. Once ready, we will collaborate on the timing of the media release and to make ourselves available for any interview requests.

Additional Tasks Completed this Period:

- Attended Society of Environmental Toxicology and Chemistry (SETAC) virtual conference.
- Completed the Atlantic water networks' Wet-pro course. This is a water quality monitoring course which gives you access to free YSI water quality probe rental though the Atlantic Water network.
- Assembled "mock mesocosms", showing experimental set up as well as likely scenario in the field with layers of contaminated sediment and reactive capping, plants and insects. This will be used as prop for media interviews, posters, and other promotional material.
- Organization of data from 2019 pilot test into publishable database (FigShare) with metadata file included.
- Research on dragonfly nymph rearing and harvesting.

Summary of Work Tasks Planned for 2021

- *Phase I Amendment Adsorption Trials*. The Phase I Hg and As adsorption experiment will focus on testing the different amendment preparations using "spiked" lab-prepared reverse-osmosis (RO) water solutions. The spiked RO water will have a fixed amount of added Hg and As to ensure consistency in order to be able to rapidly narrow down the list of reactive amendment candidates for further testing. This adsorption test will quantify experimental Hg and As adsorption capacity of different blends/ingredients that can reduce mobility of mercury and arsenic contaminants from spiked RO water.

- *Phase II Amendment Adsorption Trials*: For this phase we will use field-collected wetland sediments and overlying water from a local legacy-gold-mine-impacted wetland. The most cost-effective amendment preparations with highest adsorption capacity as determined in Phase I trials will be tested in this Phase using a slurry preparation of the wetland sediments and water. Because wetland sediments and the overlying water have more complex matrices and higher number of competing chemical bond sites compared to spiked RO water, we expect that the selected amendment adsorption capacity of Hg and As will be lower than those seen in Phase I. This itself will also provide important data for modelling potential applications for the mixed species mesocosms experiments. The second phase will allow us to determine the most appropriate dose of amendment blend to volume/mass of sediment for maximum Hg and As adsorption.

- *Mercury analysis and data analysis from Phase I and II Amendment Adsorption Trials:* We will complete Hg analysis on our samples from Phase I and II trails in our clean room laboratory at SMU. Samples will also be sent to an external laboratory for As analysis. Once chemical analysis is complete for Phase I and II Adsorption test samples (as outlined above), the amount of Hg and As adsorbed by the different amendments/combinations as well as the removal % will be calculated. Differences in adsorption values among amendments and amendment mixtures will be statistically tested using analysis of variance (ANOVA) followed by Holm-Sidak multiple comparison tests for individual differences among means.

- *Scanning Electron Microscopy (SEM) analysis:* A selection of materials from initial Phase I and II experiments will also be analysed using SEM to assess morphology and mineral composition of amendments, as well as treated and untreated sediment.

- *Preparation for first mixed species mesocosm test.* Site visits will be completed to selected contaminated wetland sites for sediment collection. We will also be preparing an artificial control sediment, mimicking the particle size distribution of the tailing sediments.

- *First mixed species mesocosm test:* Once the amendment blends/processing options with the highest adsorption capacity and appropriate dose have been determined in Phase I and II trails, the next step is completion of a 1-month bench top beaker mesocosm study. The objective of this study is to test the findings of initial batch experiments in a more environmentally realistic experimental setup with living invertebrates. Sediments will be collected from contaminated wetlands, inserted into 1L beakers and treated with the most effective amendment blend as found in initial experiments outlined above. Concentrations of As and Hg in sediment, porewater and overlaying water will be assessed. Bioaccumulation of Hg and As in invertebrates exposed to treated and untreated sediments will also be determined, as well as toxicity of treated and untreated sediments to sensitive aquatic invertebrates.

- *Chemical analysis and data analysis from 1st mesocosm test.* We will be analyzing water, porewater, sediment and tissue samples for Hg in our clean room laboratory at SMU. Samples will also be sent to external laboratory for arsenic analysis. Once chemical analysis is finalized, we will be completing data analysis.

- *Manuscript preparation:* We will start work on manuscripts to be published in peer reviewed international journals from the Phase I and II adsorption trials as well as for the 1st mesocosm study

- *Recruitment of students/technician for the April 2021 – April 2022 work period.* Ongoing.

- *Invertebrate maintenance/research and reference toxicity test.* Invertebrate maintenance and care will continue during the year. In addition, research and preparations will continue on dragon fly culturing. We anticipate collecting dragonfly nymphs this coming summer to start up a culture of these in our lab. Dragonflies are ecologically relevant to the NS wetland ecosystems so will be preferable to use in bioaccumulation studies over non-native shrimp and crayfish. In addition, prior to set up of our first mesocosm test, reference toxicity testing will need be completed in the next quarter with *Hyalella azteca* as well as *Daphnia magna.*