Appendix O

Wetlands Data

Appendix O1 – Wetland Delineation Data Forms (Wetlands WL-1 & WL-2)
Appendix O2 – WESP_AC Functional Assessment Result Scores (Wetlands WL-1 & WL-2)
Appendix O3 – Wetlands in the Vicinity of the Project Footprint Photo Plate

Appendix 01

Wetland Delineation Data Forms (Wetlands WL-1 & WL-2)

O1

WETLAND DELINEATION DATA FORM – NOVA SCOTIA

Project/Site: Northern Pulp Municipality/County: Pictou Sampling Date: June 12, 2018

Applicant/Owner: NPNS Sampling Point: WET1

Investigator(s): C. Kennedy, T. Neilly, K. Regan Affiliation: Dillon

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

Slope (%): 5% Lat: 522064 m E Long: 5055745 m W Datum: NAD83

Soil Map Unit Name/Type: Pugwash sandy to silty loam ✓ Wetland Type: Shrub Swamp

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

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

Are Vegetation No, Soil No, or Hydrology No 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 #1
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 m radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea glauca	20	✓	FAC
2. Sorbus americana	20	✓	FAC
3. Acer rubrum	10		FAC
4.			
5.			
	50	= Total Cover	

Sapling/Shrub Stratum (Plot size: 5 m radius)			
1. Alnus incana	20	✓	FACW
2. Prunus virginiana	10		FAC
3. Ilex verticilata	30	✓	FACW+
4.			
5.			
	60	= Total Cover	

Herb Stratum (Plot size: 2 m radius)			
1. Scirpus cyperinus	10		FACW
2. Osmunda cinnamomea	10		FAC
3. Valerian officinalis	5		FAC
4. Equisetum arvense	15		FAC
5. Lathyrus spp.	10		FACU
6. Galium palustre	5	✓	FACW+
7. Typha latifolia	20	✓	OBL
8.			
9.			
10.			
	75	= Total Cover	

~~Woody Vine Stratum~~ (Plot size: ~~———~~)			
1.			
2.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (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	x 2 =	
FAC species	x 3 =	
FACU species	x 4 =	
UPL species	x 5 =	
Column Totals: (A)		(B)

Prevalence Index = B/A = ____

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.)

Pond chemistry pH: 5.95 Conductivity: 0.37 uS/cm Temp: 14.6°C

O1

SOIL

Sampling Point: Wet1

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
0-18	7.5YR 2.5/2	100	—	—	—	—	Silty Clay Loam	

[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)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Polyvalue Below Surface (S8)
- ___ Thin Dark Surface (S9)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Iron-Manganese Masses (F12)
- ___ Piedmont Floodplain Soils (F19)
- ___ Red Parent Material (TF2)
- ___ 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): 0-8 inches

Water Table Present? Yes ✓ No ___ Depth (inches): @ 6-8 inches

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

Wetland Hydrology Present? Yes ✓ No ___

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

Remarks:

O1

WETLAND DELINEATION DATA FORM – NOVA SCOTIA

Project/Site: Northern Pulp Municipality/County: Pictou Sampling Date: June 12, 2018

Applicant/Owner: NPNS Sampling Point: WET2

Investigator(s): C. Kennedy, T. Neilly, K. Regan Affiliation: Dillon

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

Slope (%): — Lat: 522203 m E Long: 5055191 m W Datum: NAD 83

Soil Map Unit Name/Type: Pugwash sand, to silty loam Wetland Type: Wet meadow (depression)

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

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

Are Vegetation No, Soil No, or Hydrology No 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: Wetland #2

Remarks: (Explain alternative procedures here or in a separate report.)
Likely was a small shrub swamp prior to clearing the area + ditching
↳ naturalized now

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 10 m radius)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2. NONE			
3.			
4.			
5.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 5 m radius)			
1. Salix bebbiana	40	✓	FAC
2.			
3.			
4.			
5.			
	40 = Total Cover		
Herb Stratum (Plot size: 2 m radius)			
1. Scirpus cyperinus	30	✓	FACW
2. Galium palustre	15		FACW+
3. Typha latifolia	10		OBL
4. Drelingaria umbellata	10		FAC
5. Equisetum arvense	20	✓	FAC
6.			
7.			
8.			
9.			
10.			
	85 = Total Cover		
Woody Vine Stratum (Plot size: —)			
1.			
2.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (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 ____	x 2 = ____
FAC species ____	x 3 = ____
FACU species ____	x 4 = ____
UPL species ____	x 5 = ____
Column Totals: ____ (A)	____ (B)

Prevalence Index = B/A = ____

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.)

O1

SOIL

Sampling Point: WET 2

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 %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-12	7.5YR 4/2	100					Sandy Clay	

[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)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Polyvalue Below Surface (S8)
- ___ Thin Dark Surface (S9)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Iron-Manganese Masses (F12)
- ___ Piedmont Floodplain Soils (F19)
- ___ Red Parent Material (TF2)
- ___ 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): @ ~ 12 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): 1-2 inches
Water Table Present?	Yes ✓	No ___	Depth (inches): 1-2 inches
Saturation Present? (includes capillary fringe)	Yes ✓	No ___	Depth (inches): @ Surface

Wetland Hydrology Present? Yes ✓ No ___

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

Remarks:

Appendix 02

WESP_AC Functional Assessment Result Scores (Wetlands WL-1 & WL-2)

O2. WESP-AC Results for Wetland WL-1

Wetland Functions or Other Attributes:	Function Score (Normalised)	Function Rating	Benefits Score (Normalised)	Benefits Rating	Function Score (raw)	Benefits Score (raw)
Water Storage & Delay (WS)	3.63	Lower	10.00	Higher	4.66	5.06
Stream Flow Support (SFS)	1.97	Moderate	2.85	Moderate	1.58	1.86
Water Cooling (WC)	5.04	Higher	2.10	Moderate	3.36	1.12
Sediment Retention & Stabilisation (SR)	4.53	Moderate	10.00	Higher	5.73	10.00
Phosphorus Retention (PR)	1.38	Lower	10.00	Higher	4.61	10.00
Nitrate Removal & Retention (NR)	3.93	Moderate	10.00	Higher	5.68	10.00
Carbon Sequestration (CS)	3.26	Lower			6.74	
Organic Nutrient Export (OE)	6.35	Moderate			5.19	
Anadromous Fish Habitat (FA)	0.00	Lower	0.00	Lower	0.00	0.00
Resident Fish Habitat (FR)	6.85	Higher	6.41	Higher	3.63	4.01
Aquatic Invertebrate Habitat (INV)	8.18	Higher	6.75	Higher	6.86	4.74
Amphibian & Turtle Habitat (AM)	6.99	Higher	4.95	Moderate	6.74	6.10
Waterbird Feeding Habitat (WBF)	7.88	Higher	5.00	Moderate	6.06	5.00
Waterbird Nesting Habitat (WBN)	6.59	Higher	5.00	Moderate	4.78	5.00
Songbird, Raptor, & Mammal Habitat (SBM)	8.42	Higher	5.00	Moderate	7.25	5.00
Pollinator Habitat (POL)	7.23	Moderate	0.00	Lower	5.99	0.00
Native Plant Habitat (PH)	2.38	Lower	4.42	Lower	4.86	4.42
Public Use & Recognition (PU)			2.77	Moderate		2.20
Wetland Sensitivity (Sens)			6.27	Higher		4.65
Wetland Ecological Condition (EC)			5.65	Moderate		7.92

O2. WESP-AC Results for Wetland WL-1

Wetland Functions or Other Attributes:	Function Score (Normalised)	Function Rating	Benefits Score (Normalised)	Benefits Rating	Function Score (raw)	Benefits Score (raw)
Wetland Stressors (STR) (higher score means more stress)			10.00	Higher		5.83
Summary Ratings for Grouped Functions:						
HYDROLOGIC Group (WS)	3.63	Lower	10.00	Higher	4.66	5.06
WATER QUALITY SUPPORT Group (max+avg/2 of SR, PR, NR, CS)	3.90	Lower	10.00	Higher	6.21	10.00
AQUATIC SUPPORT Group (max+avg/2 of SFS, INV, OE, WC)	6.78	Higher	5.33	Higher	5.56	3.66
AQUATIC HABITAT Group (max+avg/2 of FA, FR, AM, WBF, WBN)	6.77	Higher	5.34	Moderate	5.49	5.06
TRANSITION HABITAT Group (max+avg/2 of SBM, PH, POL)	7.21	Higher	4.07	Lower	6.64	4.07
WETLAND CONDITION (EC)			5.65	Moderate		7.92
WETLAND RISK (average of Sensitivity & Stressors)			8.14	Higher		5.24

NOTE: A score of 0 does not mean the function or benefit is absent from the wetland. It means only that this wetland has a capacity that is equal or less than the lowest-scoring one, for that function or benefit, from among all the NS calibration wetlands that were assessed previously.

O2. WESP-AC Results for Wetland WL-2

Wetland Functions or Other Attributes:	Function Score (Normalised)	Function Rating	Benefits Score (Normalised)	Benefits Rating	Function Score (raw)	Benefits Score (raw)
Water Storage & Delay (WS)	3.69	Lower	6.94	Higher	4.70	3.08
Stream Flow Support (SFS)	1.20	Lower	0.00	Lower	0.96	0.00
Water Cooling (WC)	0.00	Lower	0.00	Lower	0.00	0.00
Sediment Retention & Stabilisation (SR)	2.52	Lower	10.00	Higher	4.16	5.00
Phosphorus Retention (PR)	1.21	Lower	6.43	Higher	4.50	5.00
Nitrate Removal & Retention (NR)	3.51	Moderate	10.00	Higher	5.38	10.00
Carbon Sequestration (CS)	1.42	Lower			5.87	
Organic Nutrient Export (OE)	2.69	Lower			3.85	
Anadromous Fish Habitat (FA)	0.00	Lower	0.00	Lower	0.00	0.00
Resident Fish Habitat (FR)	0.00	Lower	0.00	Lower	0.00	0.00
Aquatic Invertebrate Habitat (INV)	1.74	Lower	3.04	Moderate	4.26	2.84
Amphibian & Turtle Habitat (AM)	5.70	Moderate	1.99	Lower	6.06	3.82
Waterbird Feeding Habitat (WBF)	4.49	Moderate	2.50	Lower	3.45	2.50
Waterbird Nesting Habitat (WBN)	2.79	Moderate	2.50	Lower	2.02	2.50
Songbird, Raptor, & Mammal Habitat (SBM)	6.39	Moderate	2.50	Lower	5.50	2.50
Pollinator Habitat (POL)	7.48	Moderate	0.00	Lower	6.20	0.00
Native Plant Habitat (PH)	0.08	Lower	3.90	Lower	3.94	3.90

O2. WESP-AC Results for Wetland WL-2

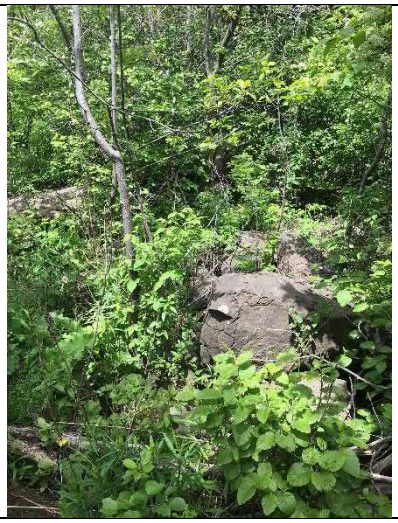
Wetland Functions or Other Attributes:	Function Score (Normalised)	Function Rating	Benefits Score (Normalised)	Benefits Rating	Function Score (raw)	Benefits Score (raw)
Public Use & Recognition (PU)			2.75	Moderate		2.19
Wetland Sensitivity (Sens)			4.84	Moderate		4.21
Wetland Ecological Condition (EC)			1.59	Lower		5.97
Wetland Stressors (STR) (higher score means more stress)			10.00	Higher		5.21
Summary Ratings for Grouped Functions:						
HYDROLOGIC Group (WS)	3.69	Lower	6.94	Higher	4.70	3.08
WATER QUALITY SUPPORT Group (max+avg/2 of SR, PR, NR, CS)	2.96	Lower	9.40	Higher	5.42	8.33
AQUATIC SUPPORT Group (max+avg/2 of SFS, INV, OE, WC)	2.05	Lower	2.03	Moderate	3.27	1.89
AQUATIC HABITAT Group (max+avg/2 of FA, FR, AM, WBF, WBN)	4.15	Moderate	1.95	Lower	4.19	2.79
TRANSITION HABITAT Group (max+avg/2 of SBM, PH, POL)	6.07	Moderate	3.02	Lower	5.71	3.02
WETLAND CONDITION (EC)			1.59	Lower		5.97
WETLAND RISK (average of Sensitivity & Stressors)			7.42	Higher		4.71

NOTE: A score of 0 does not mean the function or benefit is absent from the wetland. It means only that this wetland has a capacity that is equal or less than the lowest-scoring one, for that function or benefit, from among all the NS calibration wetlands that were assessed previously.

Appendix 03

Wetlands in the Vicinity of the Project Footprint Photo Plate

O3: Wetlands in the Vicinity of the Project Footprint Area Photo Plate

		
Ponded area within WL-1. June 12, 2018.	View of WL-1 (left) from NPNS employee parking lot (facing NE). June 12, 2018.	Dense shrubs and rip-rap on the edge of WL-1 below employee parking lot. June 12, 2018.
		
Small stand of willow trees in WL-2. June 12, 2018.	Inundation and hummocky ground within WL-2. June 12, 2018.	Small outlet channel from WL-2 into a nearby ditch Oct. 12, 2018.

O3: Wetlands in the Vicinity of the Project Footprint Area Photo Plate

		
WL-3 located immediately behind a gravelled beach area. Dec. 3, 2018.	Vegetated area of WL-3, Pictou Causeway in background. Dec. 3, 2018.	Halophytic vegetation within WL-3. Dec. 3, 2018.
		
Hummocky ground within WL-4. Dec. 3, 2018.	Suspected historic irrigation ditch within WL-4. Dec. 3, 2018.	Dense shrub growth dominates some areas within WL-4. Dec. 3, 2018.

O3: Wetlands in the Vicinity of the Project Footprint Area Photo Plate

		
WL-5A is primarily dominated by cattails with some alder growth. Dec. 3, 2018	WL-5B is located west of the Pictou traffic circle. Dec. 3, 2018	WL-5C is occupied by poplar trees and alders with WC8 dissecting through it. Dec. 3, 2018.
		
WL-5C originates at a culvert that conveys WC8 across Hwy 106. Dec. 3, 2018.	WL-5D is dominated by graminoid species with some shrub growth. Dec. 3, 2018.	WL-5D is located behind a local fish mart/ farmer's market. Dec. 3, 2018.
		
No representative photo available for WL-6	Flooded forested area within WL-7. Dec. 3, 2018.	WC9 runs through WL-7. Dec. 3, 2018.

O3: Wetlands in the Vicinity of the Project Footprint Area Photo Plate

		
Typical bog vegetation within WL-8, as seen facing NW from Hwy 106. Dec. 3, 2018.	WL-8 is largely treeless. Dec. 3, 2018.	A large ponded area of WL-9 located immediately adjacent Hwy 106, facing S. Dec. 3, 2018.
		
Many small birch trees occupy a large area within WL-10. Dec. 3, 2018.	WC11 flows through WL-10. Dec. 3, 2018.	No representative photo available for WL-11
		
WL-12A is a shallow marsh dominated by cattails and other emergent vegetation. Dec. 3, 2018.	WC13-A enters WL-12B, with Hwy 106 visible on the right, facing NE. Dec. 3, 2018	WL-12B near the location of WC13B. Dec. 3, 2018.

O3: Wetlands in the Vicinity of the Project Footprint Area Photo Plate

		
WL-13 is located immediately adjacent and to the west of Hwy 106. Dec. 3, 2018.	WC13-A flows through WL13. Dec. 3, 2018.	No representaive photo available for WL14
		
No representative photo available for WL-15	Dense shrub growth obscures an outlet channel from WL-16. Dec. 3, 2018.	WL-16 is small shrub swamp, dominated by alders. Dec. 3, 2018.

O3: Wetlands in the Vicinity of the Project Footprint Area Photo Plate

		
No representative photo is available for WL-17.	WC15 flows through WL-18. Dec. 3, 2018.	WL-18 appears impounded by the Three Brooks Rd. overpass, seen in background. Dec. 3, 2018.

Appendix P

Plant Data

Complete Plant List for ETF site by Habitat

ETF Site - Full Plant List		S Rank	Urban Disturbed	Wetland/Drainage Channel Spp	Upland Field/ Roadside Spp	Upland Forested Spp	Coastal Beach
Acer negundo	Box Elder	SE	x				
Acer platanoides	Norway Maple	SE	x				
Acer rubrum	Red Maple	S5				x	
Achillea millefolium	Common Yarrow	SE			x		
Alnus incana	Speckled Alder	S5		x			
Ammophila breviligulata	American Beachgrass	S5					x
Aralia nudicaulis	Wild Sarsaparilla	S5				x	
Arctium tomentosum	Woolly Burdock	SE	x				
Artemisia absinthium	Common Wormwood	SE			x		x
Athyrium filix-femina	Lady-Fern	S5				x	
Betula papyrifera	Paper Birch	S5				x	
Betula populifolia	Gray Birch	S5				x	
Bidens frondosa	Devil's Beggar-Ticks	S5		x			
Calamagrostis canadensis	Blue-Joint Reedgrass	S5			x		
Carex intumescens	Bladder Sedge	S5				x	
Carex scoparia	Pointed Broom Sedge	S5		x			
Cirsium arvense	Creeping Thistle	SE	x		x		
Conyza canadensis	Canada Horseweed	SE			x		
Crataegus sp	Hawthorn	not a sp at risk			x		
Daucus carota	Wild Carrot	SE			x		
Doellingeria umbellata	Parasol White-Top	S5			x	x	
Dryopteris carthusiana	Spinulose Shield Fern	S5				x	
Epilobium ciliatum	Hairy Willow-Herb	S5		x			
Epipactis helleborine	Eastern Helleborine	SE				x	
Equisetum arvense	Field Horsetail	S5	x				x
Eupatorium maculatum	Spotted Joe-Pye Weed	S5		x			
Eupatorium perfoliatum	Common Boneset	S5		x			
Euthamia graminifolia	Flat-Top Fragrant-Golden-Rod	S5	x	x	x		
Fragaria virginiana	Virginia Strawberry	S5				x	

ETF Site - Full Plant List		S Rank	Urban Disturbed	Wetland/Drainage Channel Spp	Upland Field/ Roadside Spp	Upland Forested Spp	Coastal Beach
Fraxinus americana	White Ash	S5				x	
Galeopsis tetrahit	Brittle-Stem Hempnettle	SE					x
Galium asprellum	Rough Bedstraw	S5			x		
Galium palustre	Marsh Bedstraw	S5		x			
Hieracium pilosella	Mouseear	SE				x	
Honckenya peploides	Sea-Beach Sandwort	S5					x
Hypericum perforatum	A St. John's-Wort	SE			x		
Impatiens capensis	Spotted Jewel-Weed	S5		x			
Iris versicolor	Blueflag	S5		x			
Juncus effusus	Soft Rush	S5		x			
Leontodon autumnalis	Autumn Hawkbit	SE			x		
Lilium lancifolium	Lance-Leaf Tiger Lily	SE				x	
Linaria vulgaris	Butter-And-Eggs	SE			x		x
Linnaea borealis	Twinflower	S5				x	
Lotus corniculatus	Birds-Foot Trefoil	SE			x		
Lycopus americanus	American Bugleweed	S5		x			
Myosotis laxa	Small Forget-Me-Not	S5		x			
Myrica pensylvanica	Northern Bayberry	S5	x			x	
Onoclea sensibilis	Sensitive Fern	S5		x		x	
Osmunda cinnamomea	Cinnamon Fern	S5		x			
Oxalis stricta	Upright Yellow Wood-Sorrel	S5				x	
Pastinaca sativa	Wild Parsnip	SE	x	x			
Phalaris arundinacea	Reed Canary Grass	S5	x	x			
Phragmites australis	Common Reed	S5					x
Picea glauca	White Spruce	S5			x	x	
Plantago major	Nipple-Seed Plantain	SE			x		
Polygonum hydropiper	Marshpepper Smartweed	SE		x			
Populus tremuloides	Quaking Aspen	S5			x	x	
Prunella vulgaris	Self-Heal	S5					x
Prunus virginiana	Choke Cherry	S5	x	x		x	
Ranunculus acris	Tall Butter-Cup	SE		x		x	
Rhamnus cathartica	Buckthorn	SE		x		x	

ETF Site - Full Plant List		S Rank	Urban Disturbed	Wetland/Drainage Channel Spp	Upland Field/ Roadside Spp	Upland Forested Spp	Coastal Beach
Rosa multiflora	Rambler Rose	SE		x			
Rubus idaeus	Red Raspberry	S5		x	x	x	
Rubus pubescens	Dwarf Red Raspberry	S5				x	
Rumex crispus	Curly Dock	SE		x	x		
Salix bebbiana	Bebb's Willow	S5		x			
Scirpus cyperinus	Cottongrass Bulrush	S5		x			
Senecio vulgaris	Old-Man-In-The-Spring	SE					x
Solanum dulcamara	Climbing Nightshade	S5	x				
Solidago canadensis	Canada Goldenrod	S5	x		x		
Solidago rugosa	Rough-Leaf Goldenrod	S5				x	
Sonchus arvensis	Field Sowthistle	SE	x				x
Spartina pectinata	Fresh Water Cordgrass	S5		x			x
Symphyotrichum ciliatum	Alkali American-Aster	S5				x	
Symphyotrichum lateriflorum	Farewell-Summer	S5				x	
Symphyotrichum novi-belgii	New Belgium American-Aster	S5	x	x			
Taraxacum officinale	Common Dandelion	SE	x				
Tragopogon pratensis	Meadow Goat's-Beard	SE		x			
Trifolium campestre	Low Hop Clover	SE			x		
Trifolium pratense	Red Clover	SE			x		
Tussalago farfara	Coltsfoot	SE	x		x	x	x
Typha latifolia	Broad-Leaf Cattail	S5		x			
Ulmus americanus	American Elm	S4	x				
Veronica officinalis	Gypsy-Weed	S5				x	
Viburnum opulus	Guelder-Rose Viburnum	S5				x	
Vicia cracca	Tufted Vetch	SE	x				
Viola cucullata	Marsh Blue Violet	S5				x	

*Exotic species are indicated with shading

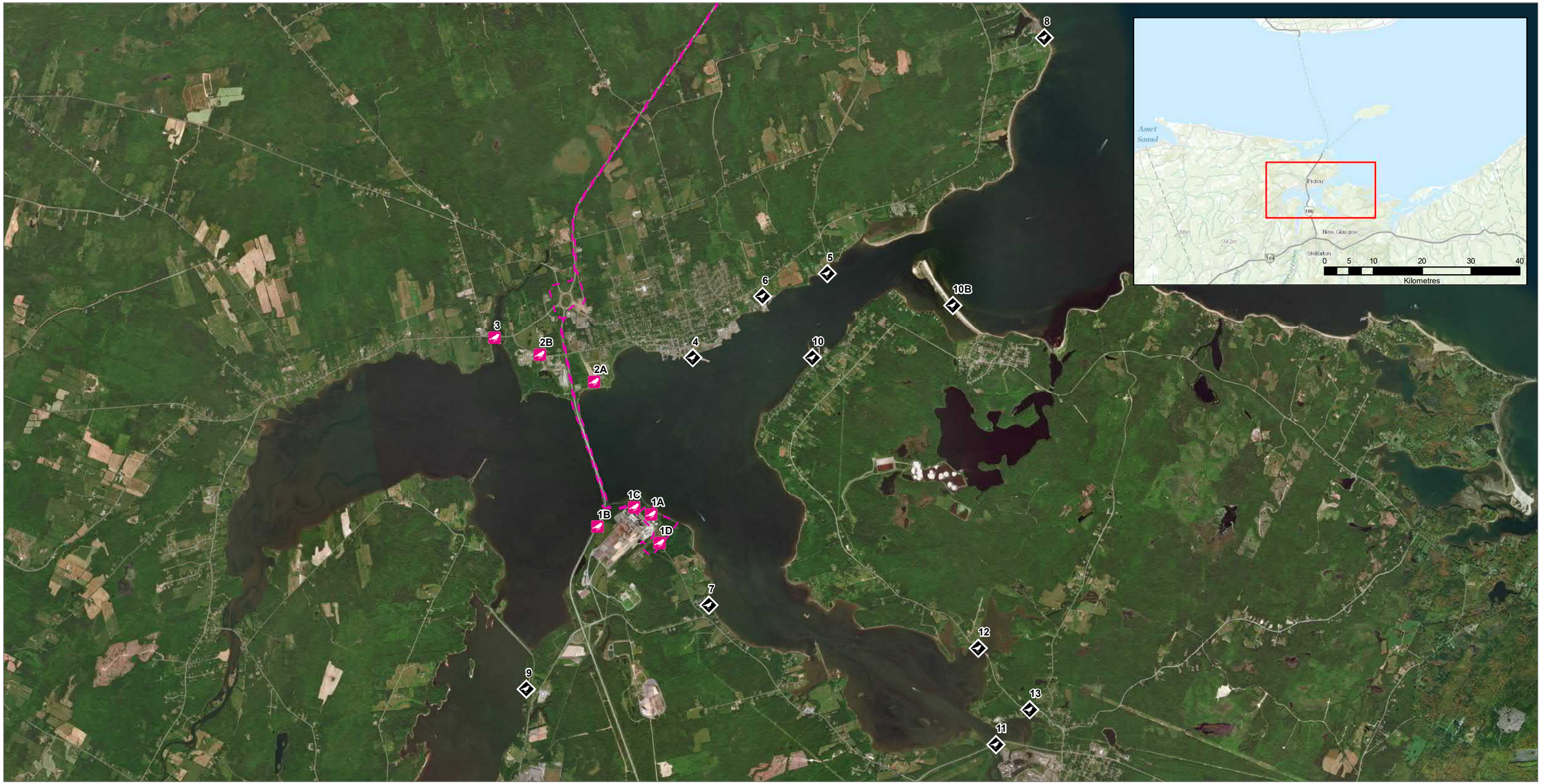
Appendix Q

Bird Data

Appendix Q1 – Avian Survey Locations
Appendix Q2 – Map of MBBA Square 20NR25
Appendix Q3 – MBBA Data Summary for Square 20NR25
Appendix Q4 – Map of MBBA Square 20NR26
Appendix Q5 – MBBA Data Summary for Square 20NR26
Appendix Q6 – Results of all Avian Survey Efforts

Appendix Q1

Avian Survey Locations



Northern Pulp Nova Scotia Corporation

Replacement Effluent Treatment Facility
Environmental Assessment

Avian Survey Locations
Figure Q-1

NORTHERN PULP
NOVA SCOTIA CORPORATION
A PAPER EXCELLENCE COMPANY

Survey locations included in the assessment

Survey locations included only in Appendix Q

Approximate Project Footprint Area*

*Surveys occured between December 2017 and June 2018

DILLON CONSULTING

MAP DRAWING INFORMATION:
DATA PROVIDED BY Northern Pulp Nova Scotia, ESRI

MAP CREATED BY: SCM
MAP CHECKED BY: AB
MAP PROJECTION: NAD 1983 UTM Zone 20N

0 0.5 1 2 3 4
Kilometres

N W E S

*Precise Project Footprint to be determined following completion of detailed design

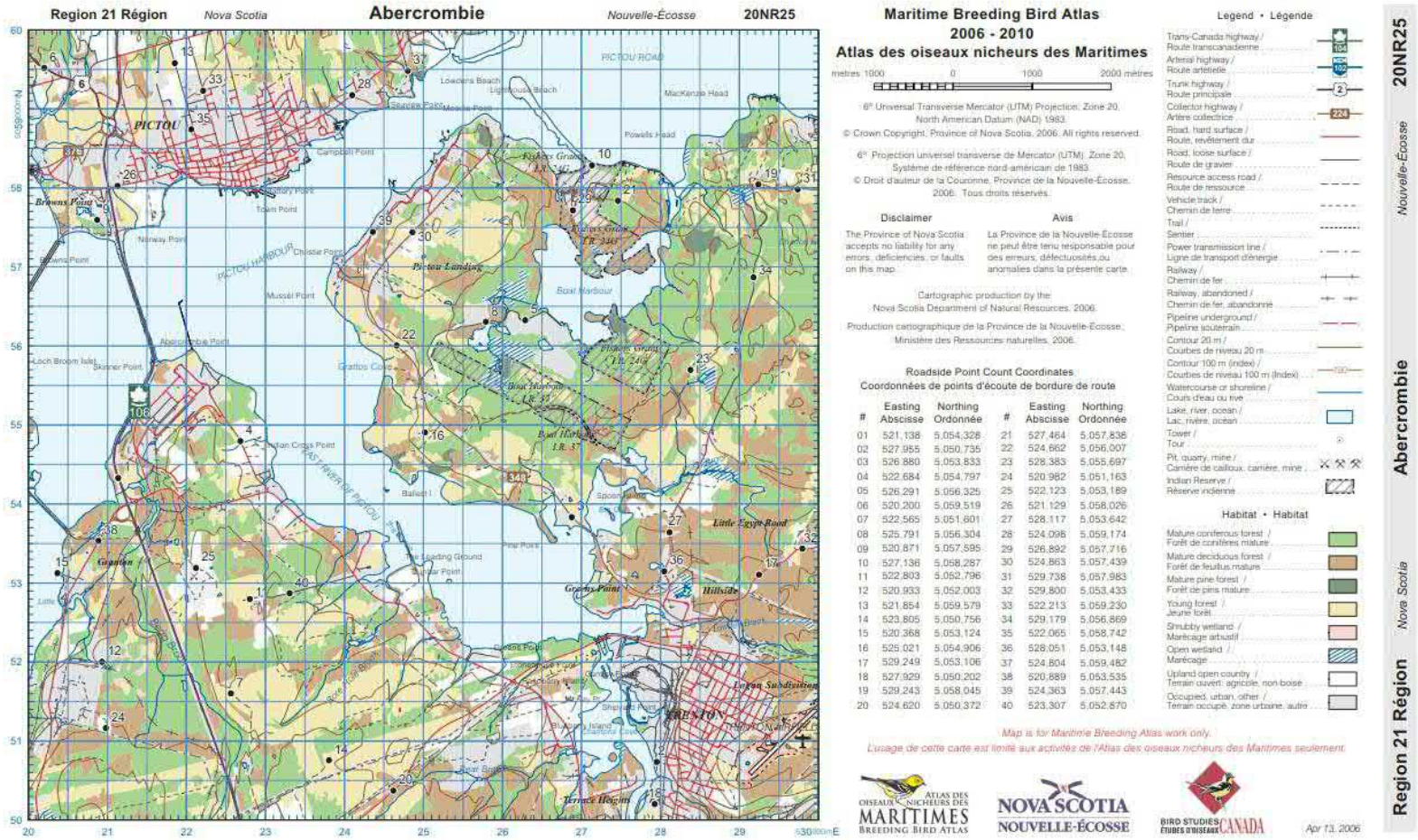
PROJECT: 17-6461

Date: 2019-01-30

Appendix Q2

Map of MBBA Square 20NR25

Q2. 10 x 10km survey area for MBBA Square 20NR25



Appendix Q3

MBBA Data Summary for Square 20NR25

Q3. MBBA Data Summary for Square 20NR25

ATLAS DES OISEAUX NICHEURS DES MARITIMES
BREEDING BIRD ATLAS

Square Summary (20NR25)

#species (1st atlas)				#species (2nd atlas)				#hours		#pc done	
poss	prob	conf	total	poss	prob	conf	total	1st	2nd	road	offrd
46	9	34	89	24	46	39	109	16	81.2	16	0

Region summary (#21: Cobequid)

#squares	#sq with data		#species		#pc done	target #pc
	1st	2nd	1st	2nd		
67	62	65	146	167	508	251

Target number of point counts in this square: 14 road side, 1 off road (1 in Mature coniferous). Please try to ensure that each off-road station is located such that the entire 100m radius circle is within the prescribed habitat.

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Canada Goose		FY	0	53	Northern Harrier		H	46	76	Short-eared Owl †			1	1
Wood Duck		P	20	52	Sharp-shinned Hawk			22	38	North Saw-whet Owl			11	36
Gadwall ‡			0	3	Northern Goshawk		H	12	20	Common Nighthawk †	H	D	29	55
Eurasian Wigeon ‡			0	0	Broad-winged Hawk	H	H	32	55	Chimney Swift †			32	23
American Wigeon		H	12	26	Red-tailed Hawk	H	H	46	72	Ruby-thr Hummingbird	H	H	61	100
American Black Duck	NE	FY	66	81	Virginia Rail †			6	9	Belted Kingfisher	ON	P	51	93
Mallard	H	T	9	60	Sora		FY	16	52	Yellow-bellied Sapsucker		T	50	83
Blue-winged Teal	P		27	26	Common Gallinule †			3	1	Downy Woodpecker	FL	A	48	89
Northern Shoveler ‡			3	4	American Coot †			4	0	Hairy Woodpecker	FL	FY	54	87
Northern Pintail			8	1	Semipalmated Plover †			6	0	Am Three-toed Woodpecker †			0	0
Green-winged Teal	H	T	24	56	Piping Plover †	NE	D	3	3	Black-back Woodpecker			20	26
Ring-necked Duck	P	FY	32	72	Killdeer	FL	FY	56	64	Northern Flicker	H	FS	80	98
Greater Scaup †			0	0	Spotted Sandpiper	H	FY	50	70	Pileated Woodpecker	H	P	45	80
Common Eider ‡§			0	1	Greater Yellowlegs †			0	3	American Kestrel	H		50	75
Hooded Merganser	P	FY	9	50	Willet		FY	14	24	Merlin		NY	16	47
Common Merganser	H	H	25	55	Wilson's Snipe	H	T	62	73	Olive-sided Flycatcher †		T	38	66
Red-breast Merganser	H		4	7	American Woodcock	H	D	22	81	Eastern Wood-Pewee	H	D	56	70
Gray Partridge			6	4	Ring-billed Gull ‡§			0	0	Yellow-bellied Flycatcher		T	30	56
Ring-necked Pheasant		S	20	69	Herring Gull §			8	10	Alder Flycatcher	H	T	79	100
Ruffed Grouse	FL	H	58	86	Great Black-backed Gull §			8	6	Willow Flycatcher †			1	1
Spruce Grouse			20	30	Common Tern §	H	NE	9	12	Least Flycatcher	H	T	59	84
Common Loon		H	29	35	Arctic Tern ‡§			1	0	Eastern Phoebe			12	58
Pied-billed Grebe		FY	24	30	Black Guillemot ‡§			0	3	Gr Crested Flycatcher			6	4
Double-crest Cormorant §	NY	NY	8	12	Rock Pigeon	H	AE	59	78	Eastern Kingbird	H	D	45	47
American Bittern			22	55	Mourning Dove	FL	FY	27	95	Blue-headed Vireo	H	CF	61	92
Great Blue Heron §	ON	H	29	13	Yellow-billed Cuckoo ‡		H	0	1	Philadelphia Vireo ‡			1	3
Turkey Vulture ‡¤			0	0	Black-billed Cuckoo		S	9	26	Red-eyed Vireo	FL	T	82	100
Osprey	ON	NY	22	50	Great Horned Owl			40	63	Gray Jay			45	58
Bald Eagle ¤	H	NY	27	83	Barred Owl		T	35	69	Blue Jay	FL	FY	70	96

next page >>

Q3

Maritimes Breeding Bird Atlas - Summary Sheet for Square 20NR25 (page 2 of 2)

SPECIES	Code		%	
	1st	2nd	1st	2nd
American Crow	AY	NY	87	100
Common Raven	H	T	69	100
Horned Lark †			1	1
Tree Swallow	H	AE	80	93
Bank Swallow §		H	56	43
Cliff Swallow §	ON	NY	38	36
Barn Swallow	H	P	85	90
Black-capp Chickadee	FL	CF	67	98
Boreal Chickadee	H	T	53	66
Red-breast Nuthatch		T	70	81
White-breast Nuthatch	P	H	11	15
Brown Creeper		P	14	50
Winter Wren		S	38	80
Golden-crown Kinglet	H	T	69	87
Ruby-crown Kinglet	H	T	79	92
Eastern Bluebird †		T	1	16
Veery	A	T	54	61
Bicknell's Thrush †			1	0
Swainson's Thrush	H	S	66	89
Hermit Thrush	H	T	74	96
Wood Thrush †	T		4	9
American Robin	AY	CF	90	100
Gray Catbird	AY	H	54	58
Northern Mockingbird †	NY		4	3
European Starling	FL	CF	77	93
Bohemian Waxwing ‡			0	0
Cedar Waxwing	H	FY	70	100
Ovenbird	NE	FY	70	93
North Waterthrush		T	30	55

SPECIES	Code		%	
	1st	2nd	1st	2nd
Black-white Warbler	H	T	77	87
Tennessee Warbler	H		75	43
Nashville Warbler	H	T	48	86
Mourning Warbler			33	49
Common Yellowthroat	AY	CF	82	100
American Redstart	AY	CF	85	98
Cape May Warbler	AY		32	16
Northern Parula		T	72	96
Magnolia Warbler	H	T	72	96
Bay-breasted Warbler	H		40	49
Blackburnian Warbler	P	T	54	83
Yellow Warbler	AY	CF	74	92
Chestn-sided Warbler	H	T	61	86
Blackpoll Warbler			12	12
Black-thr Blue Warbler		S	8	43
Palm Warbler			22	75
Yellow-rumped Warbler	H	T	67	98
Black-thr Green Warbler	H	D	69	83
Canada Warbler †	AY	A	35	52
Wilson's Warbler			11	10
Chipping Sparrow	FL	S	69	86
Vesper Sparrow †			4	10
Savannah Sparrow	H	FY	74	86
Nelson's Sh.-tail Sparrow		CF	16	21
Song Sparrow	FL	DD	87	100
Lincoln's Sparrow	A		45	63
Swamp Sparrow	H	FY	51	95
White-throat Sparrow	NE	DD	77	100
White-crown Sparrow ‡			0	1

SPECIES	Code		%	
	1st	2nd	1st	2nd
Dark-eyed Junco	A	T	70	92
Scarlet Tanager †			4	1
Northern Cardinal ‡		FY	0	10
Rose-breast Grosbeak	H	T	69	56
Indigo Bunting ‡			1	3
Bobolink	H	T	70	69
Red-wing Blackbird	FL	CF	67	84
Rusty Blackbird †			24	21
Common Grackle	AY	CF	75	96
Brown-head Cowbird	H	T	43	18
Orchard Oriole †		S	0	1
Baltimore Oriole	AY		11	13
Pine Grosbeak			29	4
Purple Finch	H	T	67	93
House Finch †			1	4
Red Crossbill †		T	17	15
White-winged Crossbill			54	64
Pine Siskin		S	59	58
American Goldfinch	FL	S	82	100
Evening Grosbeak	H	T	50	55
House Sparrow	FL	S	79	36

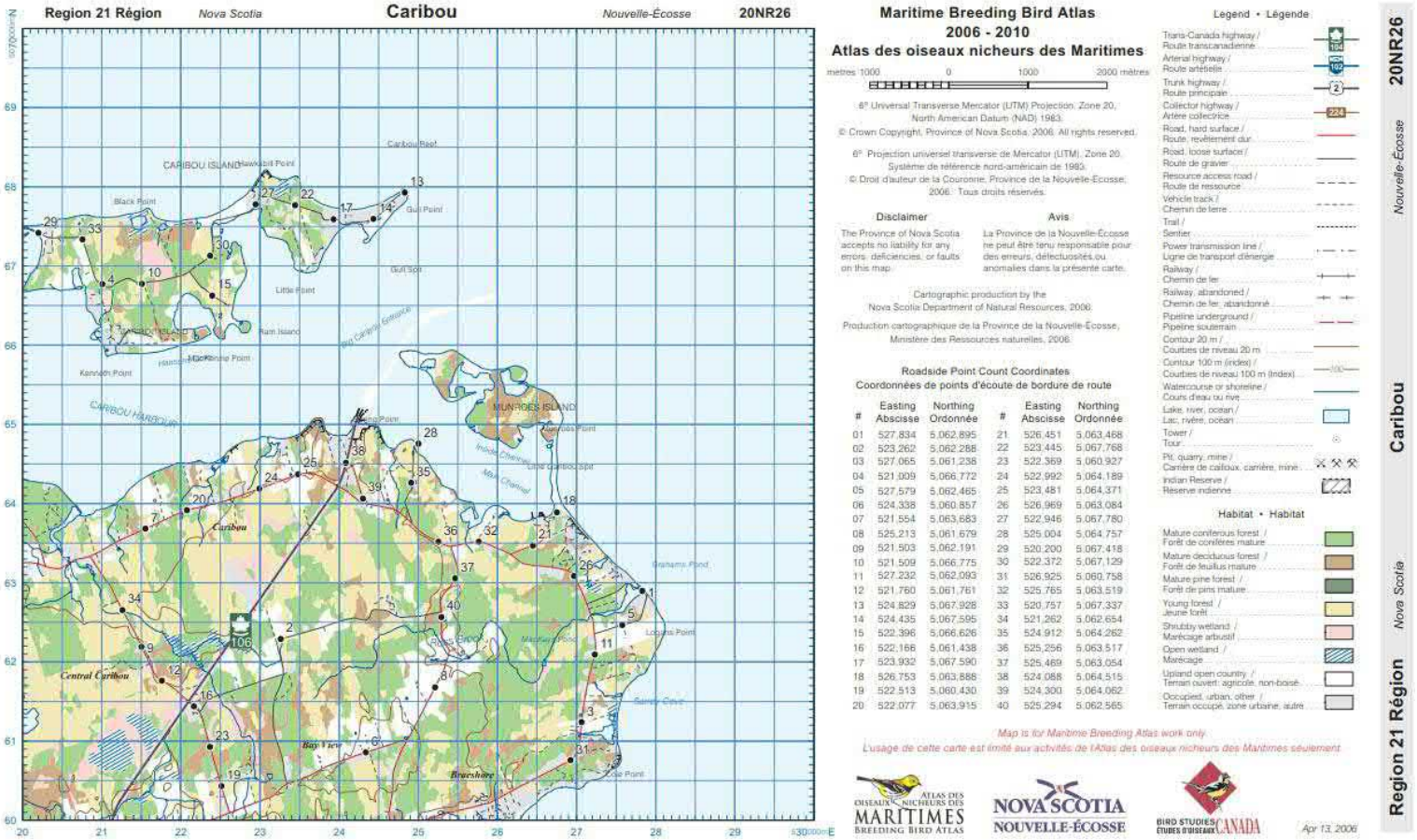
This list includes all species found during the Maritimes Breeding Bird Atlas (1st atlas: 1986-1990, 2nd atlas: 2006-2010) in the region #21 (Cobequid). Underlined species are those that you should try to add to this square (20NR25). They have not yet been reported during the 2nd atlas, but were found during the 1st atlas in this square or have been reported in more than 50% of the squares in this region during the 2nd atlas so far. "Code" is the code for the highest breeding evidence for that species in square 20NR25 during the 2nd and 1st atlas respectively. The % columns give the percentage of squares in that region where that species was reported during the 2nd and 1st atlas (this gives an idea of the expected chance of finding that species in region #21). Rare/Colonial Species Report Forms should be completed for species marked: § (Colonial), ‡ (regionally rare), † (rare in the Maritimes) or ¤ (rare in the Maritimes, documentation only required for confirmed records). Current as of 22/11/2018. An up-to-date version of this sheet is available from http://www.mba-aom.ca/jsp/summaryform.jsp?squareID=20NR25?lang=en

<< previous page

Appendix Q4

Map of MBBA Square 20NR26

Q4. 10 x 10km survey area for MBBA Square 20NR26



Appendix Q5

MBBA Data Summary for Square 20NR26

Q5. MBBA Data Summary for Square 20NR26

ATLAS DES OISEAUX NICHEURS DES MARITIMES
BREEDING BIRD ATLAS

Square Summary (20NR26)

#species (1st atlas)				#species (2nd atlas)				#hours		#pc done	
poss	prob	conf	total	poss	prob	conf	total	1st	2nd	road	offrd
5	1	2	8	29	22	50	101	0	40.5	15	0

Region summary (#21: Cobequid)

#squares	#sq with data		#species		#pc done	target #pc
	1st	2nd	1st	2nd		
67	62	65	146	167	508	251

Target number of point counts in this square: 14 road side, 1 off road (1 in Young forest). Please try to ensure that each off-road station is located such that the entire 100m radius circle is within the prescribed habitat.

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Canada Goose		H	0	53	Northern Harrier		H	46	76	North Saw-whet Owl		S	11	36
Wood Duck		V	20	52	Sharp-shinned Hawk		CF	22	38	Common Nighthawk †		FY	29	55
Gadwall ‡			0	3	Northern Goshawk			12	20	Chimney Swift †			32	23
Eurasian Wigeon ‡			0	0	Broad-winged Hawk		H	32	55	Ruby-thr Hummingbird		FY	61	100
American Wigeon			12	26	Red-tailed Hawk			46	72	Belted Kingfisher		NY	51	93
American Black Duck		FY	66	81	Virginia Rail †		S	6	9	Yellow-bellied Sapsucker		FY	50	83
Mallard		H	9	60	Sora		S	16	52	Downy Woodpecker		FY	48	89
Blue-winged Teal		P	27	26	Common Gallinule †			3	1	Hairy Woodpecker		NY	54	87
Northern Shoveler ‡			3	4	American Coot †			4	0	Am Three-toed Woodpecker †			0	0
Northern Pintail			8	1	Semipalmated Plover †	H		6	0	Black-back Woodpecker			20	26
Green-winged Teal		P	24	56	Piping Plover †			3	3	Northern Flicker	H	FY	80	98
Ring-necked Duck		P	32	72	Killdeer		FY	56	64	Pileated Woodpecker		T	45	80
Greater Scaup †			0	0	Spotted Sandpiper		DD	50	70	American Kestrel			50	75
Common Eider ‡§			0	1	Greater Yellowlegs †			0	3	Merlin			16	47
Hooded Merganser		FY	9	50	Willet		FY	14	24	Olive-sided Flycatcher †		T	38	66
Common Merganser			25	55	Wilson's Snipe		D	62	73	Eastern Wood-Pewee		FY	56	70
Red-breast Merganser		P	4	7	American Woodcock		D	22	81	Yellow-bellied Flycatcher		S	30	56
Gray Partridge			6	4	Ring-billed Gull ‡§			0	0	Alder Flycatcher		T	79	100
Ring-necked Pheasant		FY	20	69	Herring Gull §		H	8	10	Willow Flycatcher †			1	1
Ruffed Grouse		H	58	86	Great Black-backed Gull §		H	8	6	Least Flycatcher		S	59	84
Spruce Grouse			20	30	Common Tern §		H	9	12	Eastern Phoebe			12	58
Common Loon			29	35	Arctic Tern ‡§			1	0	Gr Crested Flycatcher			6	4
Pied-billed Grebe			24	30	Black Guillemot ‡§			0	3	Eastern Kingbird			45	47
Double-crest Cormorant §		NY	8	12	Rock Pigeon		FY	59	78	Blue-headed Vireo		S	61	92
American Bittern		H	22	55	Mourning Dove		FY	27	95	Philadelphia Vireo ‡			1	3
Great Blue Heron §			29	13	Black-billed Cuckoo			9	26	Red-eyed Vireo		FY	82	100
Turkey Vulture ‡¤			0	0	Great Horned Owl			40	63	Gray Jay			45	58
Osprey		FY	22	50	Barred Owl		S	35	69	Blue Jay		FY	70	96
Bald Eagle ¤		NY	27	83	Short-eared Owl †			1	1	American Crow	P	FY	87	100

next page >>

Q5

Maritimes Breeding Bird Atlas - Summary Sheet for Square 20NR26 (page 2 of 2)

SPECIES	Code 1st	Code 2nd	% 1st	% 2nd
Common Raven		FY	69	100
Horned Lark †			1	1
Tree Swallow		CF	80	93
Bank Swallow §		AE	56	43
Cliff Swallow §			38	36
Barn Swallow		AE	85	90
Black-capp Chickadee		FY	67	98
Boreal Chickadee		S	53	66
Red-breast Nuthatch		FY	70	81
White-breast Nuthatch			11	15
Brown Creeper		T	14	50
Winter Wren		H	38	80
Golden-crown Kinglet		FY	69	87
Ruby-crown Kinglet		P	79	92
Eastern Bluebird †			1	16
Veery			54	61
Bicknell's Thrush †			1	0
Swainson's Thrush		S	66	89
Hermit Thrush		T	74	96
Wood Thrush †		S	4	9
American Robin		NY	90	100
Gray Catbird		S	54	58
Northern Mockingbird †		T	4	3
European Starling		CF	77	93
Bohemian Waxwing ‡			0	0
Cedar Waxwing		AE	70	100
Ovenbird		DD	70	93
North Waterthrush		A	30	55
Black-white Warbler		FY	77	87
Tennessee Warbler			75	43
Nashville Warbler		FY	48	86
Mourning Warbler			33	49
Common Yellowthroat		T	82	100
American Redstart		CF	85	98
Cape May Warbler			32	16
Northern Parula		T	72	96
Magnolia Warbler		CF	72	96
Bay-breasted Warbler			40	49
Blackburnian Warbler		T	54	83
Yellow Warbler		CF	74	92
Chestn-sided Warbler		S	61	86
Blackpoll Warbler			12	12
Black-thr Blue Warbler			8	43
Palm Warbler	AY	S	22	75
Yellow-rumped Warbler		CF	67	98
Black-thr Green Warbler		T	69	83
Canada Warbler †		CF	35	52
Wilson's Warbler			11	10
Chipping Sparrow		H	69	86
Vesper Sparrow †			4	10
Savannah Sparrow		CF	74	86
Nelson's Sh.-tail Sparrow		S	16	21
Fox Sparrow ‡		S	0	1
Song Sparrow	H	FY	87	100
Lincoln's Sparrow			45	63
Swamp Sparrow		FY	51	95
White-throat Sparrow		T	77	100
White-crown Sparrow ‡			0	1
Dark-eyed Junco	H	FY	70	92
Scarlet Tanager †			4	1
Northern Cardinal ‡			0	10
Rose-breast Grosbeak			69	56
Indigo Bunting ‡			1	3
Bobolink		FY	70	69
Red-wing Blackbird		FY	67	84
Rusty Blackbird †			24	21
Common Grackle		CF	75	96
Brown-head Cowbird		H	43	18
Baltimore Oriole		S	11	13
Pine Grosbeak	H		29	4
Purple Finch		P	67	93
House Finch †			1	4
Red Crossbill †			17	15
White-winged Crossbill		P	54	64
Pine Siskin			59	58
American Goldfinch		AE	82	100
Evening Grosbeak		S	50	55
House Sparrow	NY	FY	79	36

This list includes all species found during the Maritimes Breeding Bird Atlas (1st atlas: 1986-1990, 2nd atlas: 2006-2010) in the region #21 (Cobequid). Underlined species are those that you should try to add to this square (20NR26). They have not yet been reported during the 2nd atlas, but were found during the 1st atlas in this square or have been reported in more than 50% of the squares in this region during the 2nd atlas so far. "Code" is the code for the highest breeding evidence for that species in square 20NR26 during the 2nd and 1st atlas respectively. The % columns give the percentage of squares in that region where that species was reported during the 2nd and 1st atlas (this gives an idea of the expected chance of finding that species in region #21). Rare/Colonial Species Report Forms should be completed for species marked: § (Colonial), ‡ (regionally rare), † (rare in the Maritimes) or ¤ (rare in the Maritimes, documentation only required for confirmed records). Current as of 22/11/2018. An up-to-date version of this sheet is available from http://www.mba-aom.ca/jsp/summaryform.jsp?squareID=20NR26?lang=en

<< previous page

Appendix Q6

Results of all Avian Survey Efforts

Q6. Results of all Avian Survey Efforts

	Survey Location	Site 1A	Site 1B	Site 2A	Site 2B	Site 3	Site 4	Site 5	Site 6	Site 7	Site 9	Site 11	Site 1A	Site 1B	Site 2A	Site 2B	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 10	Site 12	Site 13	Site 1A	Site 1B	Site 2A	Site 2B	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 10	Site 10B
	Date:	7-Dec-17											26-Jan-18													20-Mar-18											
	Time (24h):	11:02-11:22	11:37-11:45	12:03-12:27	12:40-12:50	12:52-1:10	13:22-13:32	13:36-13:44	13:50-14:00	14:50-15:00	14:23-14:28	14:35-14:37	9:57-10:17	10:31-10:41	11:05-11:15	13:35-13:40	13:43-13:48	11:20-11:40	12:08-12:10	11:50-11:57	12:20-12:25	12:30-12:35	14:12-14:22	14:25-14:32	14:39-14:49	10:07-10:23	10:45-10:55	11:19-11:39	13:04-13:14	11:07-11:14	11:55-12:05	12:20-12:25	12:08-12:18	12:50-12:55	12:30-12:40	13:40-13:50	13:57-14:07
	Temperature (C):	2	3	3	5	5	4	4	4	5	5	5	-12	-12	-12	-11	-11	-12	-11	-10	-11	-10	-10	-10	-10	-5	-4	-3	-3	-4	-3	-3	-3	-3	-3	-3	-3
	Cloud Cover (%):	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	60%	50%	36%	29%	29%	36%	36%	58%	36%	36%	100%	100%	100%	42%	42%	38%	46%	38%	26%	26%	26%	46%	46%	44%	44%
	Wind (km/h):	4	7	7	5	5	7	12	12	10	10	10	15	14	14	17	17	14	17	18	17	18	18	18	18	14	19	19	23	19	19	17	19	23	23	18	18
	Precipitation:	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Visibility:	>5 km	>5 km	>5 km	>5 km	>5 km	>5 km	>5 km	>5 km	>5 km	>5 km	>5 km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km
Common Name	Bird Species																																				
Alder Flycatcher	Empidonax alnorum																																				
American Black Duck	Anas rubripes		3			50				9		2	4				50	9		4					250	2			3			3	2		1		
American Crow	Corvus brachyrhynchos																																				
American Goldfinch	Spinus tristis																																				
American Redstart	Setophaga ruticella																																				
American Robin	Turdus migratorius																			1																	
American Wigeon	Mareca americana																																				
Bald Eagle	Haliaeetus leucocephalus																									9	3	1					1	2		9	8
Barn Swallow	Hirundo rustica																																				
Barrow's Goldeneye	Bucephala islandica													6																							
Belted Kingfisher	Megaceryle alcyon																																				
Black-and-white Warbler	Mniotilta varia																																				
Black-capped Chickadee	Poecile atricapillus																																				
Black-throated Green Warbler	Setophaga virens																																				
Blue-headed Vireo	Vireo solitarius																																				
Blue Jay	Cyanocitta cristata																																				
Bonaparte's Gull	Chroicocephalus philadelphia	40	150	20		1750	3	10	5	15	2000	10																									
Bufflehead	Bucephala albeola	10								3			4												1	3											
Canada Goose	Branta canadensis				750					75																			12								
Cedar Waxwing	Bombycilla cedrorum																																				
Chestnut-sided Warbler	Setophaga pensylvanica																																				
Chipping Sparrow	Spizella passerina																																				
Cliff Swallow	Pertrochelidon pyrrhonota																																				
Common Goldeneye	Bucephala clangula	50	25	20		2			3	34			150	20	25			10	6	7	12	20		51	130	10	3	1									
Common Grackle	Quiscalus quiscula																																				
Common Loon	Gavia immer																																				
Common Merganser	Mergus merganser	13				70				6	60		12	40	5		1	67		48				100	17	30	20			5							
Common Eider	Somateria mollissima																					1															
Common Raven	Corvus corax																			1	4																
Common Tern	Sterna hirundo																																				
Common Yellowthroat	Geothlypis trichas																																				
Double-crested Cormorant	Phalacrocorax auritus					1	6																														
Downy Woodpecker	Picoides pubescens																																				
Eastern Phoebe	Sayornis phoebe																																				
Eastern Wood-pewee	Contopus virens																																				
European Common Gull	Larus canus																	1																			
European Starling	Sturnus vulgaris																																				
Gray Catbird	Dumatella carolinensis																																				
Great Black-backed Gull	Larus marinus				5						4		6					1		3	1	3				3	4	1			30		4		1		
Great Blue Heron	Ardea herodias																																				
Great Cormorant	Phalacrocorax carbo			1																																	
Greater Scaup	Aythya marila	3												500	250			20						5		4	500	150									
Hairy Woodpecker	Picoides villosus																																				
Hermit Thrush	Catharus guttatus																																				
Herring Gull	Larus argentatus	5	3	2	300	50	10	1		2	2		11		2			32	2	1	3	1				5		7		6	20		4			1	
Hooded Merganser	Lophodytes cucullatus	1				70							1											1	27			2								
Iceland Gull	Larus glaucoides		1		1	2	5		2		5							50				10								2	8		4				
Killdeer	Charadrius vociferus																																				
Lesser Black-backed Gull	Larus fuscus					1																															
Lesser Scaup	Aythya affinis			2						25				2										1				2									
Long-tailed Duck	Clangula hyemalis	40	10	25				1																												3	
Mallard	Anas platyrhynchos					75																			5												
Mourning Dove	Zenaida macroura																																				
Northern Gannet	Morus bassanus																																				
Northern Flicker	Colaptes auratus																				2																
Northern Parula	Setophaga americana																																				
Osprey	Pandion haliaetus																									2											
Ovenbird	Seiurus aurocapilla																																				
Purple Finch	Haemorhous purpureus																																				
Red-breasted Merganser	Mergus serrator	150						2					5		1			7		2		1	1		5	150	20	200				50	100	50	75	25	20
Red-eyed Vireo	Vireo olivaceus																																				
Red-throated Loon	Gavia stellata			1						2																											
Red-winged Blackbird	Agelaius phoeniceus												1																								
Ring-billed Gull	Larus delawarensis			2		100	5	2	2	20			1					13							25	10	1	1		20	6		1			1
Ring-necked Pheasant	Phasianus colchicus																																				
Rock Pigeon	Columba livia																	58		1																	
Ruby-throated Hummingbird	Archilochus colubris																																				
Savannah Sparrow	Passerculus sandwichensis																																				
Scoter spp.	Melanitta spp.																																				
Song Sparrow	Melospiza melodia																																				
Spotted Sandpiper	Actitis macularis																																				
Tree Swallow	Tachycineta bicolor																																				
Tufted Duck	Aythya fuligula													1																							
White-throated Sparrow	Zonotrichia albicollis																																				
Yellow Warbler	Setophaga petechia																																				
Yellow-rumped Warbler	Setophaga coronata																																				
Totals Species per site		9	6	8	4	11	5	5	4	10	5	2	10	6	5	0	2	11	2	9	5	6	1	5	8	11	7	9	2	4	4	2	6	3	3	4	3

Q6. Results of all Avian Survey Efforts

	Survey Location	Site 12	Site 13	Site 1A	Site 1B	Site 2A	Site 2B	Site 3	Site 4	Site 5	Site 6	Site 8	Site 10	Site 10B	Site 1A	Site 1B	Site 1C	Site 1D	Site 2A	Site 2B	Site 3	Site 4	Site 5	Site 8	Site 10	Site 10B	
	Date:			14-May-18											16-Jun-18												
	Time (24h):	14:14-14:19	14:19-14:20	9:40-10:10	10:26-10:46	11:24-11:40	10:55-10:57	11:00-11:10	11:45-11:55	12:10-12:33	12:00-12:05	12:45-12:48	13:27-13:37	13:50-14:23	07:00 - 07:25	08:05 - 08:15	07:30 - 07:40	07:45 -07:55	05:29 - 05:50	06:04 - 0614	05:00 - 05:12	08:18 - 08:40	08:55 -09:05	09:15 - 09:25	10:45 - 10:55	09:45 - 10:30	
	Temperature (C):	-3	-3	12	13	15	15	13	15	15	15	16	16	18	14	15	14	15	12	12	11	16	17	17	20	19	
	Cloud Cover (%):	29%	29%	17%	24%	16%	28%	16%	14%	25%	14%	25%	8%	6%	-	-	-	-	-	-	-	-	-	-	-	-	
	Wind (km/h):	14	14	14	18	20	18	18	20	20	20	20	20	24	6	6	6	6	10	8	12	6	4	4	2	2	
	Precipitation:	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	
	Visibility:	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	>5km	
Common Name	Bird Species																										Total
Alder Flycatcher	Empidonax alnorum														6			6	11	5	4			3		2	37
American Black Duck	Anas rubripes							1													5		5				403
American Crow	Corvus brachyrhynchos			8		5		3	3	6	2	2	1	1	2		6			10	2	2	4	3	2	6	68
American Goldfinch	Spinus tristis			6		5				5	1				9	6	2	3	2	2		15	2		2	3	63
American Redstart	Setophaga ruticella														10		3			5	4	6	4	1	1	1	35
American Robin	Turdus migratorius			4		4		4		2					2	1		1	6	4	10	5	4	2	1		51
American Wigeon	Mareca americana	2																									2
Bald Eagle	Haliaeetus leucocephalus			3	1	1	1		1	1				4							1						46
Barn Swallow	Hirundo rustica			1					3													1				1	6
Barrow's Goldeneye	Bucephala islandica																										6
Belted Kingfisher	Megaceryle alcyon			1				2												1			1				5
Black-and-white Warbler	Mnioltilta varia																			1	3		2		1		7
Black-capped Chickadee	Poecile atricapillus					3				4							5	5		2	1		5			3	28
Black-throated Green Warbler	Setophaga virens																1										1
Blue-headed Vireo	Vireo solitarius									1																	1
Blue Jay	Cyanocitta cristata									1	1									2		2	3	1		2	12
Bonaparte's Gull	Chroicocephalus philadelphia				100					2																	4105
Bufflehead	Bucephala albeola	2																									23
Canada Goose	Branta canadensis						16	1												2							856
Cedar Waxwing	Bombycilla cedrorum														2	1	2	15	3	11			20	1		1	56
Chestnut-sided Warbler	Setophaga pensylvanica														1				1	2					1	1	6
Chipping Sparrow	Spizella passerina																			3	1		1				5
Cliff Swallow	Pertrochelidon pyrrhonota															1	20	5									26
Common Goldeneye	Bucephala clangula	2																									581
Common Grackle	Quiscalus quiscula			1						5	3								3	2	2	6	4	4	1		31
Common Loon	Gavia immer																				1						1
Common Merganser	Mergus merganser	70						2																			566
Common Eider	Somateria mollissima																										1
Common Raven	Corvus corax					1		1		2		11		10					5		2		1				38
Common Tern	Sterna hirundo			60	100		1						9	20													190
Common Yellowthroat	Geothlypis trichas																		1	2				2		10	15
Double-crested Cormorant	Phalacrocorax auritus			20	100	3			9	6	13	14	75	50	11	165			5	3		20		20	60	15	596
Downy Woodpecker	Picoides pubescens												1										2	1			4
Eastern Phoebe	Sayornis phoebe																						1				1
Eastern Wood-pewee	Contopus virens																				1		1				2
European Common Gull	Larus canus																										1
European Starling	Sturnus vulgaris			36		4		5	8	5	1	1	1	2		1	20	1	30	35	2	50	3	3	5	2	215
Gray Catbird	Dumatella carolinensis																			1		1					2
Great Black-backed Gull	Larus marinus																										66
Great Blue Heron	Ardea herodias							2							1			1	3	1	3						11
Great Cormorant	Phalacrocorax carbo																										1
Greater Scaup	Aythya marila																										1432
Hairy Woodpecker	Picoides villosus			1																							1
Hermit Thrush	Catharus guttatus									1											4						5
Herring Gull	Larus argentatus											1															471
Hooded Merganser	Lophodytes cucullatus	7						12																			121
Iceland Gull	Larus glaucoides																										90
Killdeer	Charadrius vociferus					2																					2
Lesser Black-backed Gull	Larus fuscus																										1
Lesser Scaup	Aythya affinis																										32
Long-tailed Duck	Clangula hyemalis																										79
Mallard	Anas platyrhynchos		8												2												90
Mourning Dove	Zenaida macroura						1									2			2		1				1	8	15
Northern Gannet	Morus bassanus											1															1
Northern Flicker	Colaptes auratus																						2	1	1	1	7
Northern Parula	Setophaga americana									2		1			1			1						1			6
Osprey	Pandion haliaetus			3					1		1							1			1						9
Ovenbird	Seiurus aurocapilla																1						2				3
Purple Finch	Haemorhous purpureus									1					1				2	1		1			1	1	8
Red-breasted Merganser	Mergus serrator			2	10																						876
Red-eyed Vireo	Vireo olivaceus														8	1	4	4	6	3	7	7	6	2	4	5	57
Red-throated Loon	Gavia stellata																										3
Red-winged Blackbird	Agelaius phoeniceus							2		1				1		5					2			5			17
Ring-billed Gull	Larus delawarensis				3								1														214
Ring-necked Pheasant	Phasianus colchicus							1		1											1			1			4
Rock Pigeon	Columba livia			3		10		1	2						8	2		2	7			25					119
Ruby-throated Hummingbird	Archilochus colubris																			1							1
Savannah Sparrow	Passerculus sandwichensis					2									4		4		7							5	22
Scoter spp.	Melanitta spp.														25												25
Song Sparrow	Melospiza melodia			9		6		2	2	2	1	1	1	1	5	2	3	3	7	5	6	10	3		2	4	75
Spotted Sandpiper	Actitis macularis																						2			8	10
Tree Swallow	Tachycineta bicolor			30			1			2				2													35
Tufted Duck	Aythya fuligula																										1
White-throated Sparrow	Zonotrichia albicollis					1				1							1										3
Yellow Warbler	Setophaga petechia														10	4	4		21		20	10	7	2	5	8	91
Yellow-rumped Warbler	Setophaga coronata									2					5		5	5					1				18
Totals Species per site		5	1	16	6	13	5	14	8	21	8	8	7	9	19	12	15	14	18	23	23	15	24	17	15	20	76

Appendix R

Scientific Literature BKME Effects on Lobster

A Summary of the Scientific Literature Related to the Effect of Bleached Kraft Mill Effluent on the American Lobster (*Homarus americanus*)

Prepared for:
Dillon Consulting Limited
137 Chain Lake Drive
Halifax, Nova Scotia

Prepared by:
K. Fraser Clark PhD
Mount Allison University
63 York Street,
Sackville NB

Submitted August 27, 2018

Amended January 25, 2019

Executive Summary

Mount Allison University was commissioned by Dillon Consulting Limited to produce a report on the potential effects of treated bleached kraft mill effluent (BKME) in relation to the proposed release from the Northern Pulp Nova Scotia Corporation (NPNS) mill at Abercrombie Point, Nova Scotia, on the American lobster (*Homarus americanus*).

Lobster exposure studies involving BKME were conducted in the 1960s in Nova Scotia, examining BKME's impact on adult and larval life stages. These studies considered lethality, and impacts from temperature, salinity, and dissolved oxygen. Caution must be taken in interpreting these findings as the chemical and physical composition of the BKME used in these studies is different than the composition of the BKME currently being produced at NPNS, and different also than the treated BKME which is currently discharged from the existing Boat Harbour Effluent Treatment Facility.

Lethality: Studies from the 1960's found that larval lobster survivability was impacted very little in less than 10% untreated BKME and that adult lobsters were much more resistant to untreated BKME than larval lobsters (Sprague and McLeese, 1968a, 1968b). However, due to the range of individual lobster susceptibility, and the considerable change in chemical composition of today's treated BKME, it is recommended that lethality testing, along with additional exposure tests, be completed with today's treated BKME to determine the impact that treated BKME will have on American lobsters.

Temperature, salinity and dissolved oxygen: The anticipated temperature of the treated BKME effluent (as modelled by Stantec, 2017; Stantec, 2018) proposed to be released into the Caribou Point/Northumberland Strait receiving waters would have very little impact on larval and adult lobsters if the dissolved oxygen is higher than 1.75 mg/L and salinities are higher than 21 parts per thousand (ppt). The predicted dissolved oxygen of the treated BKME is 1.5 mg/L, but will rapidly increase to greater than 1.75 mg/L within 2 m of the diffuser port, due to mixing with ambient seawater (Stantec, 2017; Stantec, 2018). The salinity of the receiving water is modeled to reach background levels of salinity within 2 m of the diffuser (Stantec, 2018), which has not been found to affect lobster behaviour or physiology (Sprague and McLeese, 1968a, 1968b).

Other species: Many more studies have been conducted on the impacts of BKME on freshwater and marine fishes and mollusks than on the American lobster. It is impossible to extrapolate the toxicological findings in fishes and mollusks to the American lobster because they have very different susceptibilities to chemicals, and very different detoxification mechanisms. Caution should be taken when examining any study that proposes to do so.

Note:

This report uses the Stantec Preliminary Receiving Water Study for Northern Pulp Effluent Treatment Plant Replacement, Pictou Harbour, Nova Scotia report (Stantec, 2017) and the Stantec Addendum Receiving Water Study for Northern Pulp Effluent Treatment Facility Replacement Prokect- Additonal Outfall Location CH-B, Caribou Point, Nova Scotia (Stantec,

2018) as the basis for determining the location, composition and behaviour of the released treated BKME. It is important to note that the values and distances in the Stantec reports (Stantec 2017, Stantec 2018) have been generated through modelling and not through onsite testing. Therefore, if modeling predictions prove to be inaccurate, then the predicted impact on lobsters as described in this report are invalid. All available peer-reviewed scientific manuscripts and scientific reports related to the effects of the chemical and physical characteristics of BKME on American lobster have been reviewed.

Background Related to Bleached Kraft Mill Effluent from the Northern Pulp Mill

The Northern Pulp Nova Scotia Corporation (NPNS) operates a bleached kraft pulp mill in Abercrombie Point, Nova Scotia. The kraft process converts wood into cellulose fiber wood pulp using sodium hydroxide, sodium sulfide and heat to break wood into its constituent fibers. The process involves the partial recycling of liquid chemical components, but also results in wastewater ('effluent'). Untreated effluent is referred to as bleach kraft mill effluent (BKME). The BKME currently being produced at NPNS is treated at the existing Boat Harbour Effluent Treatment Facility and then discharged into the Boat Harbour lagoon, which discharges to the Northumberland Strait. Northern Pulp Nova Scotia Corporation is currently undertaking a design and Class 1 Environmental Assessment for a replacement treatment facility, where the BKME will undergo primary and secondary treatment on NPNS land prior to being carried via pipeline to an engineered outfall and released in the area offshore of the Caribou Point/ Caribou Harbour area of the Northumberland Strait.

The purpose of this report is to examine the scientific and gray literature regarding the effect that treated BKME, or its physical and chemical constituents, could have on the American lobster (*Homarus americanus*). The first section of this report will highlight the key chemical and physical constituents of the treated BKME at NPNS to establish a reference point for the reader. Subsequent sections will relate what is known about how these constituents affect the American lobster.

The treated BKME daily maximum effluent water quality chemical and physical constituents from NPNS has been described in Table 3.2 of the Stantec Addendum Receiving Water Study for Northern Pulp Effluent Treatment Facility Replacement Project, Additional Outfall Location CH-B, Caribou Point, Nova Scotia report (Stantec, 2018). Table 3.1 from that report has been duplicated here as Table 1 for continuity. It is important to understand what is in the treated BKME in question before its effect on American lobster in the vicinity of the effluent outfall can be determined. Stantec's (2018) predicted effluent quality is used for comparison to the scientific literature for this report.

It is also relevant to note that the Stantec reported 2018 modeling is using conservative values for input into the Environmental Assessment. Stantec (2018) uses a total dissolved solids (TDS) concentration of 4,000 mg/L, while testing of the effluent by Maxxam in May 2017 found actual levels in the effluent from the existing treatment system to be between 1,200 and 1,500 mg/L (Stantec, 2018).

Background water quality parameters for the proposed Caribou Point effluent receiving area are also described in Stantec 2018, and reported here as Table 2 based on Dalziel et al., 2002; EcoMetrix Incorporated, 2016, 2007; Fisheries and Oceans Canada, 2018; Jacques Whitford Environment Limited, 1996, 1994.This report only considers the recommended discharge site (CH-B) and the results reported for the recommended discharge configuration (a 3-port diffuser), as identified in Stantec 2018. The modeled physical and chemical components of the proposed treated BKME and the discharge plume released by this configuration are listed in Table 3. The three-port diffuser system results in the plume reaching the surface water 25 m from the diffuser,

with dilution rates of 50-fold and 144-fold at 5 m and 100 m from the diffuser respectively (Stantec, 2018). The three-port diffuser setup, calculated effluent density of 996.32 kg/m^3 and receiving water density of 1,020.06 kg/m^3, show the effluent to be buoyant,. Modeling does show the plume to touch the bottom 10 m from the diffuser (Stantec, 2018).

Table 1. Expected Daily Maximum Effluent Water Quality (Table 3.2 of (Stantec, 2018)

Parameter	Unit	Value
Adsorbable Organic Halides (AOX)	mg/L	7.8
Total Nitrogen (TN)	mg/L	6.0
Total Phosphorus (TP)	mg/L	1.5
Colour	TCU	750
Chemical Oxygen Demand (COD)	mg/L	725
Biochemical Oxygen Demand (BOD_5)	mg/L	48
Total Suspended Solids (TSS)	mg/L	48
Dissolved Oxygen (DO)	mg/L	> 1.5
pH	-	7.0 to 8.5
Temperature	°C	25 (winter), 37 (summer)
Total Dissolved Solids (TDS) or Salinity	g/L	4

Table 2. Background water quality parameters for the proposed Caribou Point treated bleached kraft mill effluent receiving area. (Table 3.1 of (Stantec, 2018).

Parameter	Unit	Number of Samples	Average Value
Adsorbable Organic Halides (AOX)	mg/L	n/a	n/a
Total Nitrogen (TN)	mg/L	13	0.24
Total Phosphorus (TP)	mg/L	16	0.35
Colour	TCU	2	10.8
Chemical Oxygen Demand (COD)	mg/L	n/a	n/a
Biochemical Oxygen Demand (BOD_5)	mg/L	n/a	n/a
Total Suspended Solids (TSS)	mg/L	11	8.5
Dissolved Oxygen (DO)	mg/L	6	7.2
pH	-	13	8.0
Temperature (summer)	°C	6	17.6
Temperature (winter)	°C	2	0.0
Salinity	g/L	8	26[1]

n/a – no data available
[1] DFO (2014) shows salinity of 28 g/L around CH-B. Therefore 28 g/L was conservatively used in CORMIX

Table 3. Modeled physical and chemical parameters of treated bleached kraft mill effluent released from a three-port diffuser at proposed site CH-B at Caribou Point(Stantec, 2018).

Characteristic	At port	At 100 m from port
Depth as release site	20 m	avg 18 m
Mean Current velocity (simulated)	0.06 m/s – 0.17 m/s	0.06 m/s – 0.17 m/s
Absorbable Organic Halides	7.8 mg/L	0.05 mg/L
Total Nitrogen	6.0 mg/L	Background
Total Phosphorus	1.5 mg/L	Background
Biochemical Oxygen Demand	48 mg/L	0.33 mg/L
Chemical Oxygen Demand	725 mg/L (calculated from BOD)	5.0 mg/L
Total Suspended Solids	48 mg/L	Background
Dissolved Oxygen	1.5 mg/L	Background levels
pH	7 – 8.5	Background levels
Water Temperature	25-37 ^{o}C	Background + 0.1 ^{o}C

Treated BKME Parameters:

The following provides a description of key parameters of interest for the proposed treated BKME from Stantec (2018).

Absorbable organic halides (AOX) is a term that refers to a large group of long half-life chlorine-containing organic molecules. There are no limits on AOX in marine waters specified by either provincial or CCME guidelines (Canadian Council of Ministers of the Environment, 2003).

Total nitrogen and phosphorus concentrations are a eutrophication concern in shallow lakes and tidal bays. Elevated nutrient levels can trigger substantial algal growth and eventual anoxic events due to decomposition of the excess plant material. The amount of nitrogen released would be diluted to within normal background levels within 2 m of the diffuser. Total phosphorus released is quite low and would be within background levels less than 2 m from the outflow (Stantec, 2018). Both of these chemicals would not have direct effects on lobster at the predicted concentrations. Background conditions are modeled to be met within less than 2 m of the diffuser for the proposed treated effluent (Stantec, 2018).

Biochemical oxygen demand (BOD) refers to the amount of oxygen that would be consumed by living organisms if one liter of the sample were oxidized. It generally refers to the amount of organic material in a sample that could be metabolically oxidized by microorganisms. The higher the BOD, the more oxygen that would be consumed, resulting in lower concentrations of dissolved oxygen in the receiving water.

Chemical oxygen demand is a measure of the amount of oxygen required to chemically oxidize the organic and inorganic molecules in a sample. The potential effects for this parameter are related to dissolved oxygen levels.

The total amount of oxygen dissolved in marine waters depends on several factors including temperature, current, tides, ice cover and biological utilization. The identified background levels present in the Caribou Point area vary between 6.4 and 8.1 mg/L; with an average of 7.2 mg/L (Stantec, 2018). Changes to dissolved oxygen from the predicted effluent is modeled to be at these background levels less than 2 m from the outfall diffuser (Stantec, 2018).

Total suspended solids (TSS) are any coarse or fine solids suspended within a solution. This may include, sand, clay, sediments, plankton, microorganisms, inorganic and organic matter. The background level in the proposed Caribou Point effluent release site averages 8.5 mg/L (Stantec, 2018). The released TSS is modeled to be within Canadian Council of Ministers of the Environment marine aquatic life guideline levels less than 2 m from the diffuser.

Ambient pH levels at the Caribou Point site averages 8.0. Guidelines suggest that marine and estuarine waters shouldn't change by more than 0.2 pH units from ambient receiving waters (Canadian Council of Ministers of the Environment, 2003). The pH of the proposed effluent fluctuates daily from 7 to 8.5 and is expected to be diluted to background pH within 2 m of the diffuser (Stantec, 2018).

The maximum water temperature of the proposed effluent changes from 25 ^{o}C in the winter to 37 ^{o}C in the summer. A water temperature change of 1 ^{o}C above background is modeled to be achieved approximately 2 m from the diffuser (Stantec, 2018).

The ambient salinity of the outfall site varies from 23.7 parts per thousand (ppt) to 31.2 ppt; with a concentration gradient from higher at the seafloor to lower at shallow depths (Jacques Whitford Environment Limited, 1996). This salinity gradient is higher in the summer and much more uniform in the colder months. The Stantec 2018 model used 28 practical salinity units for their model as salinity effects several other modeled parameters including dissolved oxygen. The model predicts that the salinity of the water would be less than 1 ppt below ambient at 2 m from the diffuser (Stantec, 2018).

A Note on Extrapolating Results Between Species

There is currently much more scientific information regarding the impact of BKME on fresh water and marine fish, than on marine crustaceans (e.g. the American lobster). The purpose of this report is to focus primarily on the potential impacts of treated BKME exposure on the American lobster. There are different methods of toxicity between different species. Caution should be taken when extrapolating toxicological findings of marine fish to marine crustaceans (Sprague and McLeese, 1968a).

BKME Impact on Larval lobster

The mill at Abercrombie Point Nova Scotia began operation in September 1967. At that time, there was significant concern that the untreated BKME released into the Boat Harbour lagoon

could affect the distribution of lobster larvae in the vicinity of Pictou Road. Lobster larvae distribution surveys were conducted in 1966 and 1968 at 17 sampling sites. The authors concluded the untreated BKME was having no effect on the distribution or health of lobster larvae (Scarratt, 1969, 1968). However, the current and proposed treatment process for BKME at NPNS differs in several ways from the original BKME treatment system. Additionally, there have been many industrial process changes since the 1960's. A modified aeration system was constructed in 1993, and modified in 1996, 1997 and 2004, to improve the aerobic digestion of the effluent by adding air and nutrients to the effluent.

The studies completed in 1968 used different dilutions of the historic untreated BKME and found that the survival of stage I lobster larvae, the first post hatch lobster life-stage, is reduced slightly at 10% BKME, but not significantly at concentrations below 10% BKME (Sprague and McLeese, 1968b). It was difficult for the lethal concentration of BKME to be determined at lower BKME concentrations because of the high level of mortality in the control animals; a common feature of lobster larval studies. Larvae were able to live for two days in 32% BKME, and for 5-10 h in 100% BKME at a salinity of 30% (Sprague and McLeese, 1968b).

The results of the 1968 research suggest that lobster larvae will not be affected by the proposed treated BMKE within the effluent plume 2 m from the diffuser. However, caution should be taken in interpreting these exposure studies as the current chemical composition of BKME is different than that used in these studies.

There is no additional information in the scientific literature, or in scientific reports, on the effects of the BKME chemical components on lobster larvae. There are, however, several studies that have examined the temperature, dissolved oxygen and salinity requirements of larval lobsters.

Lobster larvae are able to survive and develop to stage IV at temperatures of 24 ^{o}C at a salinity of 30 ppt (Templeman, W., 1936). They can also develop to stage IV in salinities between 18 ppt and 35 ppt when held at temperature between 15 ^{o}C and 20 ^{o}C. This study also found that rearing larval lobsters at a salinity of 21 ppt was only slightly less favorable than rearing them at 31 ppt (Templeman, W., 1936). Templeman (1936) concluded that salinities below 19.4 ppt were detrimental, and a salinity of 16.4 ppt prevented larvae from reaching stage III. However, Sprague and McLeese have found that stage I larva reared in 14 ppt salinity had little effect on survival (Sprague and McLeese, 1968b). Stage I larval lobsters will avoid salinities of 21.4 ppt, but not 26.7 ppt at a water temperature of 17.5 ^{o}C (Scarratt and Raine, 1967). This indicates that stage I lobster larvae will preferentially avoid salinities that are below their lethal limit of 14-19 ppt. The modeled salinity is within 1 ppt of ambient 2 m from the diffuser , and this salinity has been shown to have no effect on larvae development or behaviour (Scarratt and Raine, 1967; Sprague and McLeese, 1968b; Stantec Consulting Ltd., 2018; Templeman, W., 1936).

According to Stantec 2018, the temperature of the treated BKME receiving water outside of 2 m from the effluent diffuser is modeled as being within 1 ^{o}C of ambient. The ambient temperature of surface water in the receiving area reaches 17.2 ^{o}C in the summer and even this temperature is

below the 24 ºC temperature that lobster larvae are known to survive and develop properly (Fisheries and Oceans Canada, 2018).

BKME Impact on Adult Lobster

Lobsters that have developed past larval stage IV inhabit benthic environments and could inhabit the proposed area for the diffuser ports in the Caribou Point area. Past studies on exposure of adult lobsters to different concentrations of untreated BKME were completed in the late 1960's. They have found considerable variability between individual lobsters, where some groups had 50% mortality at 250 hours, 77 hours, and 75 hours in 32%, 56% and 75% BKME. Within the same study, lobsters were observed to have survived two weeks at the same BKME concentrations; while all groups of lobsters held in 100% BKME lived for the full 2 week trial period (Sprague and McLeese, 1968b). The variability in this experiment was too great to accurately determine the lethal concentration of historic BKME in adult lobsters (Sprague and McLeese, 1968b).

This study also examined the combined effects of salinity, down to 14 ppt, and low oxygen during BKME exposure. Reduced salinity and low oxygen were not found to be correlated with reduced susceptibility to BKME (Sprague and McLeese, 1968b). Behavioural tests were performed to determine the reaction of adult lobsters to plumes of BKME at different concentrations. Lobsters exposed to concentrations of BKME as high as 20% did not avoid it. These findings suggests that exposure to dilute concentrations of untreated BKME would not result in lobsters altering their local movement (McLeese, 1970). The existing untreated BKME exposure studies suggest that adult lobsters can survive up to 2 weeks in 100% BKME from the 1960s (Sprague and McLeese, 1968b) and do not avoid dilute concentrations of this BKME (McLeese, 1970). These findings should be interpreted with a great deal of caution because of the high individual variability of lobster susceptibility, and that the chemical composition of the untreated BKME used in these studies is different than the treated BKME currently produced at Northern Pulp Nova Scotia Corporation mill in Abercrombie Point Nova Scotia.

The optimal temperature for rapid growth of the American lobster is 22 ºC. Rearing lobsters from egg to 82 mm carapace length can take as little as two years if the lobsters are reared constantly at this temperature (Hughes et al., 1972; Van Olst et al., 1976). A behaviour thermoregulatory study examined a lobster's preference for different temperatures. It was found that lobsters avoided temperatures above 20 ºC, and preferred temperatures between 12 ºC and 18 ºC (Crossin et al., 1998). McLeese (1956) has demonstrated that at 13 ºC, 50% of exposed adult lobsters died after 48 hours when held in a salinity of 12.3-13.2 ppt, while at 25 ºC, 50% mortality at 48 hours occurred at a salinity 19 ppt. Adult lobsters will die if held at 28 ºC for longer than 48 hours; and less than 24 hours at 30 ºC. The ultimate upper acutely lethal temperature for lobsters is 32 ºC at an optimal salinity of 30 ppt and 6.4 mg/L dissolved oxygen (McLeese, 1956).

Juvenile lobsters are also known to travel much shorter distances from their shelters in search of food than adult lobsters; and inhabit the inshore zone where daily fluctuations in the water

temperature are normal. Juveniles raised in temperatures that fluctuated daily between 15 ^{o}C and 22 ^{o}C grew slower and had more mortality than juveniles raised at a constant 22 ^{o}C (Ford et al., 1979). They also found that acute temperature exposure to 31 ^{o}C resulted in greater mortality in the lobsters that were exposed to the fluctuating temperatures; suggesting less resistance to acute high temperature stress (Ford et al., 1979). This study also found that short-term, 1-2 week, exposure to fluctuating temperatures has little or no effect (Ford et al., 1979). These findings suggest that juvenile lobster present in the inshore waters surrounding the effluent diffusers could be more susceptible to high temperature stress, but that temperature would have to be at 31 ^{o}C or above.

The ambient water temperature of the receiving waters is 17.2 ^{o}C, and temperature outside of 2 m from the diffuser will not be significantly affected. Adult lobsters are mobile and can avoid temperatures that are not optimal, especially if the elevated temperature is highly localized. The effluent plume from the proposed three-port diffuser system is predicted to rise as it is a higher temperature, and less dense, than the surrounding receiving water (Stantec, 2018). However the report does note that it doesn't come into contact with the seafloor until it is 10 m from the diffuser (Stantec, 2018). As such, the temperature of the proposed effluent is not believed to be a significant cause of mortality to adult lobsters.

Moulting lobsters are more susceptible to environmental stressors such as high temperature, low oxygen and low salinity conditions than intermoult hard-shelled lobsters (McLeese, 1956). All three parameters interact to affect the physiological health of a lobster, where an extreme condition in any one of these parameters will decrease the tolerance to the others. Adult lobsters can be held successfully at 25 ^{o}C for several days (Chaisson, 1932). However, lobsters were unable to survive more than 7.5 hours at a salinity of 11.4 ppt, or 13 hours at a salinity of 19.5 ppt at temperatures of 11^{o}C and 13 ^{o}C respectively (Chaisson, 1931). The prediction of salinity being within 1 ppt of background concentrations 2 m from the diffuser suggests that there will be no impact caused by the low salinity of the treated BKME (Stantec, 2018).

The lethal dissolved oxygen level for lobsters at 48 hours is below 1.75 mg/L, even at temperatures as high as 28.5 ^{o}C, and salinities as low as 20 ppt (McLeese, 1956). Exposure of lobsters to dissolved oxygen levels above 1.75 mg/L during summer months, when temperatures are elevated, is unlikely to cause lethality as the ambient salinity has been reported to be 30 ppt at this time of year (Fisheries and Oceans Canada, 2018). However, it could become an issue if the salinity was to drop below 20 ppt, and the lobsters was exposed to these conditions for 48 hours. The Stantec (2017) reports suggests that this is unlikely as the warmer and less dense effluent will rise from the diffuser ports. McLeese (1956) has also reported that lobsters can withstand exposure to lethal environmental levels of temperature, salinity and dissolved oxygen if the exposure doesn't exceed 48 hours.

Impact on Benthic Macroinvertebrates

Historically, the impact of BKME on macroinvertebrates near the point of proposed effluent release has been studied for the Abercrombie Point Mill. Peer (1972) undertook an ecological examination of the marine benthic invertebrate fauna in Pictou Road before, 1967, and after, 1969, the opening of the mill at Abercrombie Point Nova Scotia. The purpose of their experiment was to report any changes that may have occurred over that time that could be linked to the effects of the effect of untreated BKME, at that time, on marine life and commercial fisheries in the Pictou, Nova Scotia area. They found that different benthic invertebrates responded differently to the BKME; which is due to the different mechanisms of toxicity and detoxification present in different invertebrate species. The changes in macroinvertebrate diversity were greatest in shallow areas closer to the Boat Harbour discharge point. The largest changes were in an increase in nematodes, which is an indicator of increasing anaerobic conditions (Peer, 1972). This effect is normally associated with changes in the benthic sediment caused by deposition of particulate matter from untreated BKME (Bagge, 1969; Waldichuk, 1959). This finding is assumed to be reflective of the lack of primary treatment in 1960's. There has since been seven surveys of benthic invertebrate diversity in the Pictou Road BKME receiving area and all tests, conducted from 1996-2016, have found no difference in the assemblages of benthic invertebrates related for treated BKME release from NPNS (EcoMetrix Incorporated, 2016). Today's BKME treatment system observes additional suspended solid reduction from the outlet of the effluent treatment facility and Boat Harbour lagoon outlet.

Similar long-term changes in benthic invertebrate communities have also been reported in Sweden and India (Bagge, 1969; Negi and Rajput, 2013). A study conducted on the effects of six years (1964-1970) of sustained BKME effluent discharge in Loch Linnhe-Eil Scotland UK, found that it increased the population of some mollusks (*Corbula gibba*, *Thyasura flexuosa* and *Myrtea spinifera*) and the crustacean *Idotea neglecta*. The authors attribute this to the increase organic loading into the system from the mill effluent (Pearson, 1972). Changes in benthic invertebrate diversity due to BKME (Bagge, 1969; Negi and Rajput, 2013; Pearson, 1972) could positively impact the American lobster if it results in an increase in its food source, or be detrimental if it decreases its food source. There is not enough information to determine which of these outcomes is most likely. More recent studies involving benthic marine invertebrate surveys has found that BKME induced eutrophication, a major source of environmental damage caused by toxic and/or smothering effects (Government of Canada, 2002).

Studies on the blue mussel (*Mytilus edulis*) have demonstrated that continuous exposure to 0.5% BKME has long term effects on the survivability of mussels, and reduces their lipid concentrations (Kinnee, 2005). Studies on Pacific oyster (*Crassostrea gigas*) exposure to BMKE have found that larval stages are very susceptible to BKME with mortality occurring at concentrations as low as 0.003% BKME (Woelke, 1967). However the author of this study purposefully stated that extrapolations about BMKE toxicity to other species, based on the findings in Pacific oysters, should not be made (Woelke, 1967).

Additional Notes on Extrapolating Historic Research

Conditions in the Northumberland Strait are complex and difficult for modeling to accurately predict. In addition, climate change and ocean acidification make predicting outcomes and impacts into the future difficult.

Conclusion

Adult lobsters occupy the benthic environment. The resultant plume from the proposed engineered discharge (Stantec 2018) is predicted to reach the benthic environment 10 m from the outfall location. At this distance, dilution rates are 70-fold, and no impact on the benthic environment and adult lobsters would be anticipated. Previous scientific studies conducted using the historic effluent showed a high variability in survival rates but suggest that adult lobsters are not likely to be impacted, particularly at the area where the effluent plume would be interacting with them.

Lobster larvae will be within the water column and could come into contact with the proposed treated effluent plume. Previous scientific studies suggest that lobster larvae are not expected to be affected by the proposed treated BKME within 2 m of the diffuser due to the predicted dilution rate at this distance.

Based on the understanding of historic scientific testing results, and with the proposed and predicted improvements made to the NPNS mill facility and the Boat Harbour Treatment Facility, it is unlikely that the temperature, dissolved oxygen and salinity interactions of the treated effluent will affect either larval or adult lobster.

Recommended Scientific Research

- Studies to more accurately assess the potential for impact to adult lobsters including lethality, behavior, and sublethal impacts are recommended to be carried out with current treated BKME.
- Completing studies of lobster larvae with today's treated BKME would allow for confirmation and better understanding of potential lethal and sublethal effects.

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