# HIGHWAY 104 TWINNING
## Sutherlands River to Antigonish
## Aquatic Environment - Technical Report

CBCL LIMITED
Consulting Engineers

NOVA SCOTIA
Transportation and Infrastructure Renewal

151046.14 ● Report ● November 2018

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**APPENDICES**

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## ACRONYMS

| | |
|---|---|
| ACCDC | Atlantic Canada Conservation Data Centre |
| ATV | All-Terrain Vehicle |
| BCAF | Bluenose Coastal Action Foundation |
| CCME | Canadian Council of Ministers of the Environment |
| CEAA | *Canadian Environmental Assessment Act* |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| cm | Centimetre |
| CRA | Commercial Recreational Aboriginal |
| CRI | Canadian Rivers Institute |
| DFO | Fisheries and Oceans Canada |
| EC | Environment Canada |
| DNR | Department of Natural Resources |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| L | Litre |
| LiDAR | Light Detection and Ranging |
| m | metre |
| mg | milligram |
| mm | millimetre |
| NSDFA | Nova Scotia Department of Fisheries and Aquaculture |
| NSDNR | Nova Scotia Department of Natural Resources |
| NSE | Nova Scotia Department of Environment |
| NSESA | *Nova Scotia Endangered Species Act* |
| NSGC | Nova Scotia Geomatics Centre |
| NSTIR | Nova Scotia Department of Transportation and Infrastructure Renewal |
| ODNR | Ohio Department of Natural Resources |
| OMNR | Ontario Ministry of Natural Resources |
| s | Second |
| SARA | *Species at Risk Act* |
| µs | Microsecond |
| USDA | United States Department of Agriculture |
| VEC | Valued Ecosystem Component |
| VES | Visual Encounter Surveys |
| WAM | Wet Areas Mapping |
| WC | Watercourse |

# CHAPTER 1 INTRODUCTION

## 1.1 Project Overview

CBCL Limited (CBCL) was contracted by the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) to prepare an Environmental Assessment (EA) Registration document for proposed highway twinning of Highway 104, Sutherlands River to Antigonish. In 2018, supplementary and additional field programs were completed for avifauna, wetlands, vegetation, lichen, aquatics, fish and fish habitat, noise, bats, and moose.

The present study is specific to the aquatic environment within Highway 104 (Sutherlands River to Antigonish). In the event that the Highway Twinning were to proceed, this study endeavours to document a suitable baseline of data, as may be required for:

- Facilitating future regulatory requirements;
- Establishing conservation priorities for species of conservation concern;
- Defining project design constraints; and
- Implementing mitigation measures during construction and operational phases of the project.

## 1.2 Previous Studies

Between 2015 and 2017, CBCL completed a Highway Twinning Feasibility Study for Highway 104 on behalf of NSTIR. This Study consisted of a number of components which included environmental elements as indicated below:

- Preliminary Screening Assessment:
  - Desktop environmental constraints assessment;
  - Environmental regulatory review;
- Detailed Feasibility Study;
  - 2016 Environmental Field Programs:
    - Site Reconnaissance, Breeding Birds, Moose, Owls, Wood Turtles, Aquatics, Wetlands, and Vegetation; and
  - 2017 Environmental Field Programs:
    - Wood turtles.

During the *Preliminary Screening Assessment*, CBCL performed a desktop constraints analysis and identified several Valued Ecosystem Components (VECs) which may interact with the proposed Highway Twinning Project, among which included watercourses, fish and fish habitat, and wood turtle habitat. A variety of data sources were used during the desktop constraints analysis, including:

- Aerial imagery;
- Provincial Geographic Information Systems (GIS) databases:
  - Nova Scotia Geomatics Centre (NSGC) 1:10000 rivers and streams;
  - Nova Scotia Department of Lands and Forestry (NSDNR) wet areas mapping (WAM);
- Light Detection and Ranging (LiDAR) products; and
- NSDNR watershed and wood turtle distribution mapping.

A number of environmental field studies investigating these VECs have since been completed. A summary of the findings from the aquatics program for Highway 104 are presented in this report.

## 1.3 Project Boundaries

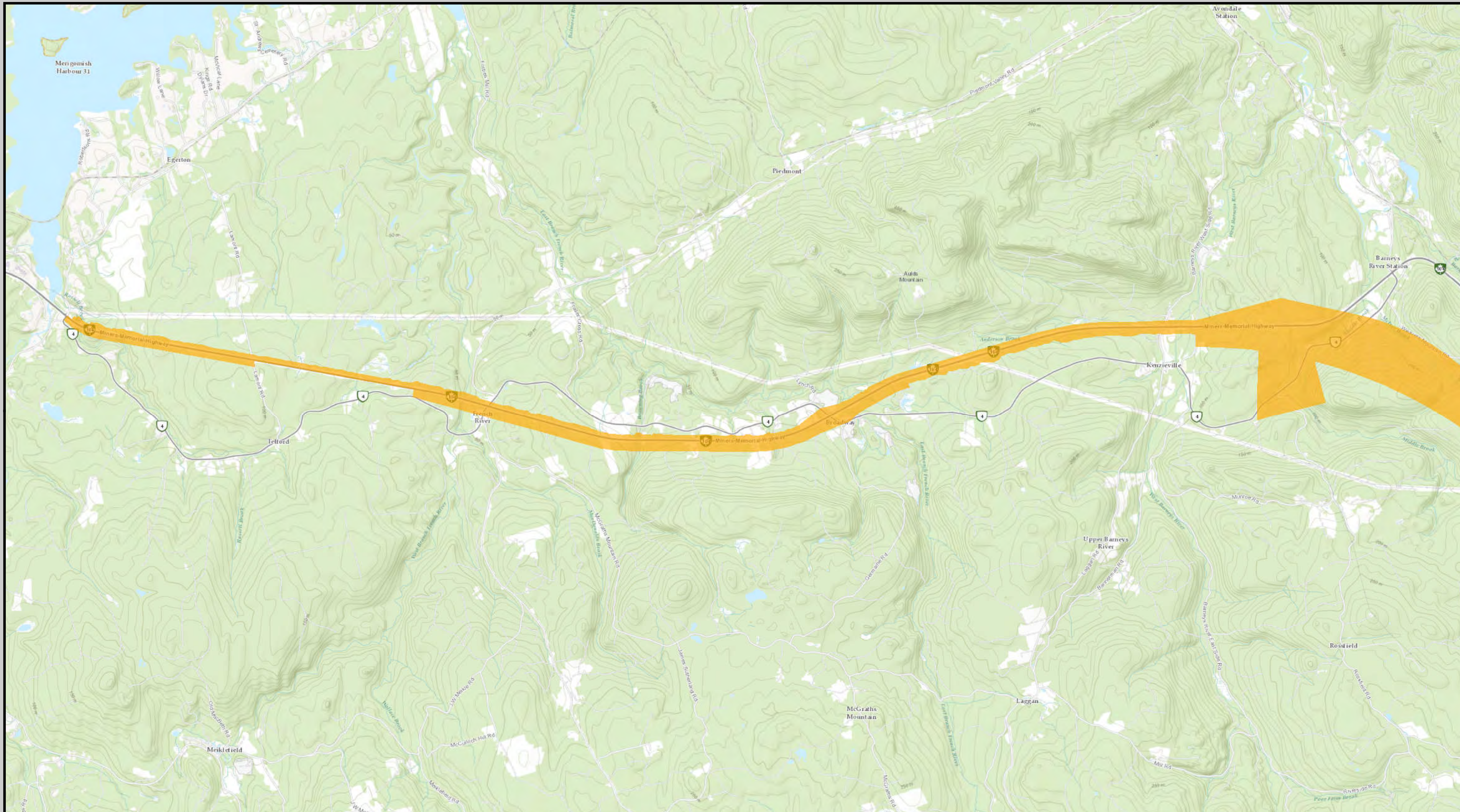
The proposed highway corridor will link the twinned Highway 104 infrastructure east of Sutherlands River to the twinned Highway 104 infrastructure west of Antigonish (Figure 1.1). The proposed route will include twinning two segments of the existing alignment in addition to the construction of an all new four-lane highway. This new infrastructure will diverge from the present alignment at Barneys River Station and reconnect west of Exit 30.

Highway 104 (Sutherlands River to Antigonish) is divided into three subsections:

- Sutherlands River to Barneys River;
- Barneys River Station to James River; and
- James River to Antigonish.

***Project Area***: The 'Project area' (PA) is defined as the Right-of-way for the new highway alignment which includes the daylighting extent or area of impact of the Project; this would include any areas of vegetation clearing, grubbing, cut and fill, etc.

***Study Area***: The 'Study Area' is defined as the area surveyed, which is the 'Project Area' plus a minimum additional distance of 50 m measured laterally from the 'Project Area', in both the upstream and downstream directions. The entire watercourse was often assessed when it ran parallel to the proposed crossing. The Wood Turtle Study Area was developed in consultation with Nova Scotia Lands and Forestry (NSDNR), and entailed survey of various distances upstream and downstream from the Project Area on select watercourses.

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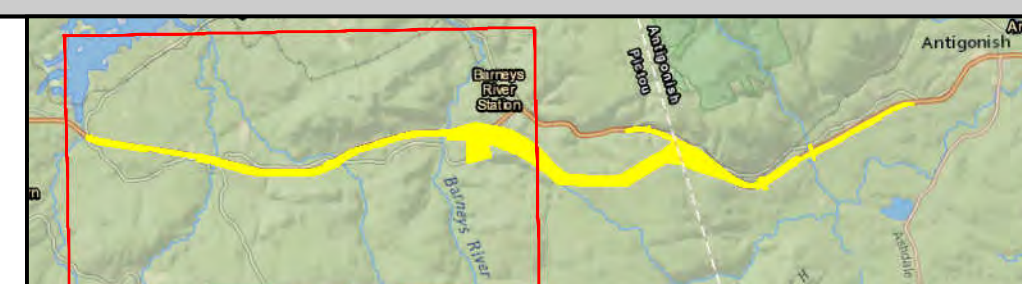
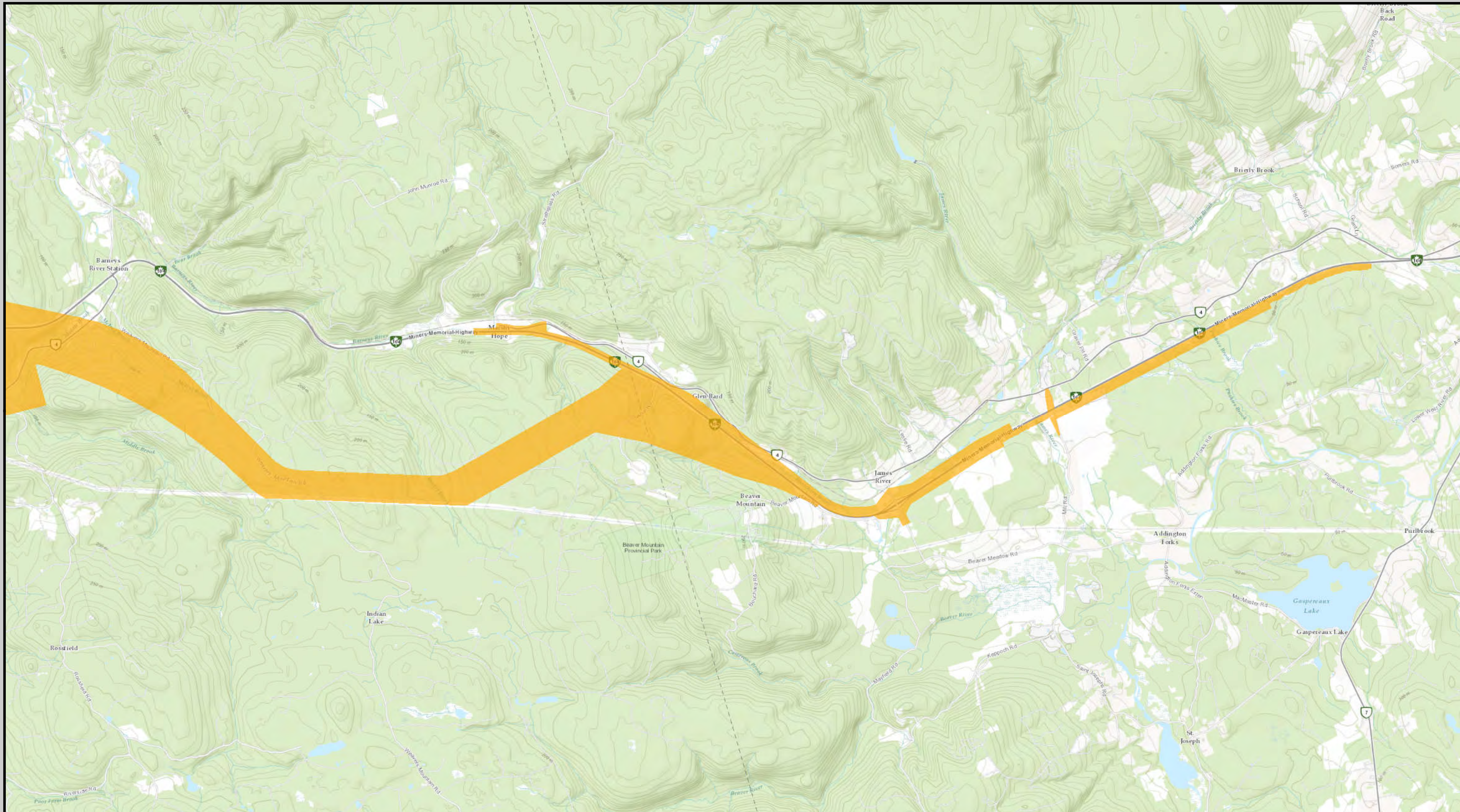
NSTIR Highway 104
Figure 1.1
Sutherland's River to Antigonish,
Pictou & Antigonish Counties, NS
19/09/2018

0 630 1,260 1,890 2,520 m
1:50,000 Scale when printed at 11"x17"

Study Area






Nova Scotia Transportation and Infrastructure Renewal

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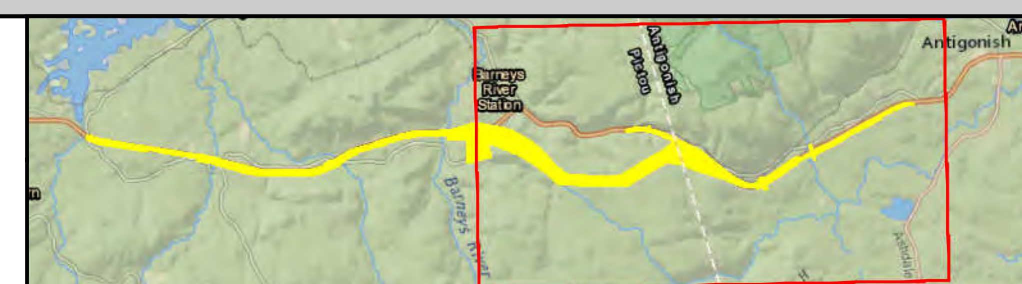

#### *1.3.1 Biophysical Setting*

This section of Highway 104 intersects with the Pictou Antigonish Highlands (west of Antigonish), St. George's Bay (surrounding Antigonish), and the Northumberland Lowlands (east of Sutherlands River) ecodistricts (Neily et al., 2005).

The Pictou Antigonish Highlands ecodistrict is defined by well drained, sandy loamy soils. Soils derived from shales are also common. Tolerant hardwood and mixedwood forests consisting of American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), red spruce (*Picea rubens*) and sporadic eastern hemlock (*Tsuga canadensis*) can be located along on the crests and the upper and middle reaches of hills and larger hummocks. Eastern hemlock is often associated with steep slopes along the banks of watercourses. Red spruce and eastern hemlock are predominantly located in the low-lying areas with black spruce (*Picea mariana*) occupying poorly drained sites. Coarser soils that were deposited during the melting of the glaciers, often found along stream banks, will support stands of white pine (*Pinus strobus*). Old fields that were once tolerant hardwood stands are reclaimed by white spruce (*Picea glauca*).

The St. George's Bay ecodistrict includes most of Antigonish County and extends towards the Cape Breton Hills. This low-lying area is characterised by cool springs, and warm, moist summers. These climatic conditions produce prime growing conditions as seen by the abundance of agricultural lands amongst the rolling hills. Soils are primarily imperfectly drained to moderately drained gravel to gravelly clay loams. Well drained gravelly sand loams are often associated with major tributaries. Gypsum outcrops and karst topography, areas that often support the growth for rare species, are found along the cliffs of St. George's Bay. Natural forest stand compositions are infrequent due to the extensive agricultural disturbance. Abandoned agricultural lands have been reclaimed primarily by white spruce. Under normal conditions, it is likely that tolerant hardwoods including American beech, sugar maple, and yellow birch would be present along the upper hillslopes, while tolerant softwoods including red spruce, eastern hemlock, and white pine would be found along the low-lying areas. Black spruce and tamarack (*Larix laricina*) could be common amongst imperfect to poorly drained soil types.

The Northumberland Lowlands ecodistrict extends along the Northumberland Strait into New Brunswick, seldom exceeding 50 m above sea level. This area is bounded and sheltered by the Cobequid Mountains, Pictou Antigonish Highlands, and the Cumberland Hills. The soils are defined by compact, imperfectly drained red sandstones and shales with better drained sandy loams occurring on the upper slopes of rolling hills. This area consists primarily of black and red spruce. After a disturbance, either natural (i.e., fire) or anthropogenic (i.e., forest harvesting), early successional species including balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), white birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), and largetooth aspen (*Populus grandidentata*) will likely become established. Tolerant hardwood stands are uncommon to rare in this ecodistrict but can occur along the upper hillslopes with better drained soils.

## 1.4 General Approach

The *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory of British Columbia* (Resource Inventory Committee, 2001) and the *Habitat Suitability Index Models* for brook trout (*Salvelinus fontinalis*) (Raleigh, 1982) were used as guides in the development of the field program and were reviewed by each field team lead to establish consistent survey techniques for fish habitat assessments. Each watercourse identified during the site reconnaissance was revisited to determine habitat suitability for salmonid spawning, rearing, and overwintering.

Surveys were conducted to determine the presence of wood turtles (*Glyptemys insculpta*) and their habitats. NSDNR developed a map illustrating 31 wood turtle priority watersheds in Nova Scotia (MacGregor and Elderkin, 2003). Using this map, wood turtle priority watercourses within the Study Area along Highway 104 were identified. During the first phase of the field program, habitat assessments were conducted on the identified watercourses. NSDNR also identified wood turtle critical habitat that occurs within or in close proximity to the Study Area. For the second phase of the wood program, two rounds of visual encounter surveys (VES) were conducted, in fall of 2016 and spring of 2017. VES were conducted on watercourses that were either recommended by CBCL for further assessment following the wood turtle habitat assessment surveys, or by the advice of NSDNR.

The over-arching intent of the study was to generate products that would support future regulatory submissions in support of the Project's eventual development; these primarily include (but are not limited to) Environmental Assessment applications to NS Environment, pursuant to the *Environment Act*.

# CHAPTER 2 METHODOLOGY

## 2.1 Program Development

### *2.1.1 Fish Habitat Assessments*

Two documents, *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory* (Resource Inventory Committee, 2001) and the *Brook Trout Habitat Suitability Index Model* (Raleigh, 1982), were used to develop the habitat assessment datasheet (Appendix A). Each of these documents provides comprehensive details on the habitat requirements for each life stage of brook trout. This information was incorporated into an analysis of habitat quality for salmonids for the Study Area watercourses.

### *2.1.2 Wood Turtle Habitat Assessment*

As previously discussed, wood turtles (*Glyptemys insculpta*) are designated as 'Threatened' federally and provincially under SARA (Schedule 1) and the NSESA, respectively. Wood turtles are also ranked as S2 ('Imperiled') by ACCDC (ACCDC, 2018b).

In Nova Scotia, wood turtles have been reported in 31 watersheds throughout the province, although little is known about their abundance in many of these areas (MacGregor and Elderkin, 2003). The wood turtle is the most terrestrial of the four freshwater turtle species found in Nova Scotia, but still requires water for many of its seasonal activities such as thermoregulation, mating, and hibernation (COSEWIC, 2007; MacGregor and Elderkin, 2003). Wood turtles are associated with hard-bottomed watercourses composed of sand or gravel, and avoid watercourses with clay or muck-bottoms. They are most often associated with medium sized meandering streams between 3 and 20 m wide (Jones and Willey, 2015) with clear water and moderate current (MacGregor and Elderkin, 2003; COSEWIC, 2007).

Wood turtles overwinter in numerous microhabitat types, such as the bottoms of deep pools and under overhanging banks (EC, 2016; Jones and Willey, 2015; COSEWIC, 2007). Nesting habitat includes both natural and anthropogenic sites that receive a moderate to high amount of sunlight (COSEWIC, 2007). Common natural features deemed suitable for nesting habitat include sand or sand-gravel areas, such as sand bars, cut-banks along a watercourse, and areas of over-washed sand in open floodplains. Wood turtles will also readily use anthropogenic sites for nesting, such as gravel roads and shoulders, agricultural fields, gravel pits, bridge crossings, and beaches (MacGregor and Elderkin, 2003; COSEWIC, 2007; Jones and Willey, 2015).

The wood turtle is an opportunistic omnivore and feeds both on land and in water (Jones and Willey 2015). Wood turtles have been reported to eat a wide range of plants, fruits, invertebrates, fish, eggs, and carrion (MacGregor and Elderkin, 2003; COSEWIC, 2007; Jones and Willey, 2015).

Wood turtles face both natural and anthropogenic threats. Anthropogenic threats include loss and degradation of habitat, recreational and agricultural activities, road mortality, and the commercial pet trade (MacGregor and Elderkin, 2003; COSEWIC, 2007). Natural threats include predators, such as raccoons, skunks, coyotes, and crows. Rates of predation may increase in areas where concentrated food sources (i.e., garbage) exists (MacGregor and Elderkin, 2003; COSEWIC, 2007).

Site-level habitat assessments may help to identify key supporting landscape features required by wood turtles (Jones and Willey, 2015). To achieve these ends, a survey protocol was developed (Appendix B) to assess wood turtle habitat on sections of priority watersheds within the Study Area. A literature review was conducted to identify habitat requirements, which are further described in Section 2.4.1. In the field, a variety of environmental conditions and habitat features were documented and evaluated to determine if a watercourse and surrounding riparian area could potentially satisfy general habitat requirements. Wood turtles require three main habitat features: a watercourse that provides stable overwintering locations, a sandy nesting substrate, and varied upland habitat for foraging and thermoregulation (MacGregor and Elderkin, 2003; Jones and Willey, 2015). Upon completion of the wood turtle habitat assessments in August 2016, CBCL biologists (in consultation with NSDNR biologists and habitat databases) recommended several watercourses identified as containing areas of potential wood turtle habitat, for further assessment via Visual Encounter Surveys (VES). These VES were completed in October 2016 and in May 2017. Further details on VES are provided in Section 2.4.2.

## 2.2 Fish Habitat Assessments

Fish habitat assessments were initially conducted in August 2016. Additional surveys were completed between May and June, 2018 within the Study Area as defined in Section 1.3; some of these surveys included re-visitation of watercourses (or portions of watercourses) surveyed in 2016.

The completion of fish habitat assessments for watercourses is a requirement for Nova Scotia Environment (NSE) authorizations pursuant to the *Environment Act,* and also for Fisheries and Oceans Canada (DFO) authorizations under the Federal *Fisheries Act*. To position NSTIR for acquisition of these approvals, a fish habitat assessment designed in accordance with DFO protocols was conducted for each of the watercourses identified in the proposed corridor.

Methodology used was adapted from the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory for British Columbia: Standards and Procedures* (Resource Inventory Committee, 2001). Watercourses were surveyed as stated in Section 1.3 upstream and downstream of the proposed watercourse crossing, with general notes taken regarding the adjacent riparian habitat. Observed conditions were documented and evaluated for quality of overwintering, rearing and spawning fish habitats. Data collected included (Appendix A):

- Substrate (types and percent) for bedrock, boulders (>256 mm), cobble (65-256 mm), large gravel (17-64 mm), small gravel (2-16 mm) and fines (< 2 mm);

- Cover (relative abundance) for boulder, overhanging vegetation, large and small woody debris, undercut banks, deep pools and instream vegetation;
- Wetted and channel widths (where applicable);
- Water and pool depths (where applicable);
- Morphology of the watercourse (e.g., run, flat, pool, riffle, rapid);
- Bank characteristics (e.g., texture and shape);
- Water quality (e.g., dissolved oxygen, temperature and pH);
- Unique watercourse characteristics (e.g., confinement, bars, islands, watercourse pattern);
- Approximate velocity (where applicable);
- Barriers to fish passage (e.g., perched culverts, debris jams);
- Crown closure;
- Incidental vegetation;
- Photographs; and
- UTM locations.

Watercourses were classified as 'ephemeral', 'intermittent', 'small permanent' or 'large permanent' based on the definitions provided in Table 2.1. Small and large permanent are collectively known as 'perennial'. Compound classifications are also occasionally used, where watercourse characteristics appear to represent more than a single classification; for example 'intermittent with ephemeral characteristics' and 'small permanent with intermittent characteristics'.

**Table 2.1 Description of Watercourse Types**

| Watercourse Type | Average Channel Width | Description |
|---|---|---|
| Large Permanent | >5 m | • Defined channels;<br>• Defined beds and banks; and<br>• Year-round flow. |
| Small Permanent | 2-5 m | • Defined channels;<br>• Defined beds and banks; and<br>• Year-round flow. |
| Intermittent | <2 m | • Defined channels;<br>• Defined beds and banks; and<br>• Seasonal water flows. |
| Ephemeral | Often no defined channel | • No defined channels;<br>• No defined bed or banks; and<br>• Typically contain water resulting from rain events or snowmelt. |

An evaluation of spawning, rearing and overwintering habitat was based on the following:

- Spawning habitat quality was based on water flow and substrate (i.e., presence of large and small gravels);
- Rearing habitat quality was based on cover abundance, water flow and habitat connectivity; and
- Overwintering habitat quality was based on the presence or absence of deep pools or ponds (≥50 cm depth) and the potential for year-round flow.

The potential for fish presence year-round was based on the results of water quality measurements (see Table 2.2), habitat quality at the time of the assessment, the quality of overwintering and spring/summer habitat, and upstream/downstream connectivity of the watercourse to other watercourses. The brook trout optimum ranges for pH, DO and temperature are more restrictive than the tolerance ranges.

**Table 2.2 Water Quality Limits for Sustaining Salmonids in the Aquatic Environment**

| Water Quality Parameters | *CCME *Water Quality Guidelines for the Protection of Aquatic Life* | *Brook Trout Tolerance and Optimum Ranges* (Raleigh, 1982) |
|---|---|---|
| pH | 6.5 - 9.0 | Tolerance: 4.0 to 9.5<br>Optimal: 6.5 to 8.0 |
| Temperature (°C) | NA | Tolerance: 0.5 to 22<br>Optimal: 11.0 to 16.0 |
| Dissolved Oxygen (mg/L) | Warm Water Biota: 5.5 to 6.0<br>Cold Water Biota: 6.5 to 9.5 | Tolerance: ≥ 5.0<br>Optimal: ≥ 7.0 |

* Canadian Council of Ministers of the Environment

Brook trout is a popular game fish that was once ubiquitous in the cold water streams of eastern Canada. However, due largely to widespread fragmentation of stream habitats resulting from land use activities and other anthropogenic factors, their habitat has been reduced. Brook trout have very specific habitat requirements; including forested riparian cover, clean low nutrient water quality, cold water temperatures, and upwelling ground water or spring fed streams to aerate incubating eggs. The absence or impairment of these requirements can undermine the viability of individual populations. For this reason, brook trout are excellent management indicator species linked to high quality cold water stream systems that typically coincide with high quality forested areas (Wilson et al., 2001).

### *2.2.1 Water Quality*

Water quality measurements were collected at each watercourse in August 2016 or May and June 2018, where water depth permitted, using a Horiba U52 unit. Parameters including pH, temperature (°C), dissolved oxygen (mg/L and %), conductivity (µs/cm), total dissolved solids (g/L) and turbidity (NTU) were measured. Actions taken to collect accurate readings included:

- Calibration of the unit prior to use on the Project;
- Re-calibration of the unit a few times throughout the Project;
- Proper storage procedures; and
- Allowing sufficient time for parameters to stabilize before measurements were recorded.

### *2.2.2 Fish Sampling*

In June 2018, an electrofishing program was conducted using a Smith-Root® LR-24 Electrofisher to assist in determining the presence or absence of fish in identified watercourses in the Study Area. The following criteria was used to determine whether watercourses identified in the Study Area were electrofished:

- Watercourses that were rated as ‘poor-moderate’ or higher for overall salmonid habitat;
- Watercourses that were rated as ‘poor-moderate’ for salmonid rearing habitat;

- Watercourses that contained water levels that were high enough to submerse the anode associated with the electrofisher unit;
- Watercourses where salmonids were observed during the 2016 or 2018 fish habitat assessments were often not electrofished as presence of salmonids had already been confirmed;
- Large and small permanent named watercourses were often assumed to contain salmonids and were not electrofished. Watercourses for which salmonid (including Atlantic salmon (*Salmo salar*)) presence was assumed include the following:
    - Browning Brook;
    - French River: East and West Branches;
    - Baxter Brook;
    - James River;
    - McIver Brook;
    - Middle Brook;
    - Hartshorn Brook; and
    - West Barneys River.

Electrofishing was conducted by using the "Quick Setup" and adjusting the output voltage, duty cycle and frequency. Targeted areas were swept efficiently and effectively by putting fish in a state of electrotaxis, an induced swimming reaction that causes fish to swim towards the positive anode, allowing for capture in a dip net (Smith-Root, 2009). Key habitat areas were targeted at each location including areas for cover (under logs, vegetation and rocks), deeper sections, and areas over gravel/cobble. Each location was electrofished until fish were caught, observed (unable to be captured) or until substantial effort produced no results.

## 2.3 CRA Fisheries Assessment

A desktop review and communication with fisheries management was conducted to determine fish species presence in the Study Area along Highway 104, with a focus on species of conservation concern; commercial, recreational, and Aboriginal (CRA) fisheries; and support species. Information sources included:

- NSDNR's *Significant Species and Habitats* database;
- Consultation with DFO Fisheries Officers;
- Fisheries and Oceans (DFO) *Stock Status Reports*;
- ACCDC Data Reports (ACCDC, 2015, 2018a);
- Committee on the Status of Endangered Species in Canada (COSEWIC) reports;
- *Freshwater Fishes of the Atlantic Maritime Ecozone* (Curry and Gautreau, 2010);
- Canadian Rivers Institute (CRI) *Species Distribution Mapping* (CRI, 2014);
- Highway 104 Environmental Assessment (Jacques Whitford, 2005, 2008);
- Description of Selected Lake Characteristics and Occurrence of Fish Species in 781 Nova Scotia Lakes (Alexander et al., 1986);
- Nova Scotia Department of Fisheries and Aquaculture (NSDFA) *Lake Stocking Database* (NSDFA, 2016a, 2018a);
- NSDFA *Freshwater Fish Species Distribution Records* (NSDFA, 2016b, 2018b);
- NSDFA *Nova Scotia Anglers' Handbook and 2016 Summary of Regulations* (NSDFA, 2016c);

- NSDFA *Nova Scotia Anglers' Handbook and 2018 Summary of Regulations* (NSDFA, 2018c);
- *Surveys of Eleven Lakes in Antigonish and Guysborough Counties* (Ives, 1973); and
- *Survey of Thirteen Lakes in Antigonish and Guysborough Counties* (Richard, 1977).

## 2.4 Wood Turtle Assessment

### *2.4.1 Wood Turtle Habitat Assessments*

Wood turtle habitat assessments were conducted on 20 watercourses within the Study Area along Highway 104 (Table 2.3) in 2016. Survey details and environmental conditions were recorded at the beginning of each assessment. A variety of environmental conditions, such as water temperature, pH, and flow conditions were measured for each watercourse assessment. A complete list of environmental conditions measured is provided in Appendix B. Habitat features of the watercourse and surrounding riparian area were evaluated to determine the quality of the watercourse, overwintering sites, nesting sites, and food availability. Data collected to determine each habitat feature includes (for a complete list see Appendix B):

- Suitable stream characteristics were determined based on the following measurements: flow conditions, water clarity, velocity, and dominant substrate;
- Overwintering sites were determined by the availability of deep pools, root masses of large trees, undercut banks, oxbows, large woody debris, log jams, and boulders;
- Nesting sites were determined based on the presence of sand or sand-gravel areas such as sand bars and cut banks along the watercourse, and areas of over-washed sand in open floodplains. Anthropogenic sites that could be used for nesting were also noted; and
- Foraging potential was determined based on the availability of food sources.

CBCL biologists and technicians evaluated the potential for wood turtle habitat based on the presence of the aforementioned habitat features. Watercourses initially determined to provide potential habitat for wood turtles were recommended for a full wood turtle survey, i.e., Visual Encounter Survey (VES).

### *2.4.2 Wood Turtle Visual Encounter Surveys*

Wood turtle Visual Encounter Surveys (VES) were conducted on watercourses if a watercourse met at least one of the following criteria (Table 2.3):

- After conducting the initial habitat assessment survey, CBCL recommended the watercourse be further assessed through a VES; or
- The watercourse was identified as a priority survey area, following consultation with NSDNR biologists and habitat databases.

The VES was adapted from the protocol suggested by the Northeast Wood Turtle Working Group (NWTWG) (Jones et al., 2015; Appendix C) and involved two or more surveys of the watercourse. It was approved by Mark Pulsifer, DNR Regional Wildlife Biologist. The VES survey included information such as habitat descriptions, environmental conditions (i.e., air temperature, water temperature, cloud cover, wind, precipitation), and search effort (Appendix C). In the event that a wood turtle was encountered during the VES, a wood turtle observation form was completed. The development of the wood turtle observation form was also approved by Mark Pulsifer (Appendix C). The form included information such as sex, visible injuries, behaviour, topographic position, and descriptions of surrounding habitat.

Additionally, if an individual turtle was found, various measures (e.g., maximum carapace length and width, and the maximum shell height) would be taken. Wood turtle measurements would include those adopted from the Blanding's Turtle Recovery Team 2007 and followed by Clean Annapolis River Project (CARP) (Hann, 2013). Before VES surveys were conducted, a *Species at Risk Scientific Permit* was acquired from the NSDNR Wildlife Division (Appendix D).

**Table 2.3 Watercourses within the Study Area on which Wood Turtle Surveys were Conducted**

| Watercourse ID | Watercourse Type | Survey Types Conducted | |
|---|---|---|---|
| | | Habitat Assessment | Visual Encounter Survey |
| WC-09 | Large Permanent | | ✓ |
| WC-29 | Large Permanent | | ✓ |
| WC-50 | Small Permanent | ✓ | |
| WC-55 | Intermittent | ✓ | |
| WC-56 | Intermittent | ✓ | |
| WC-57 | Small Permanent | ✓ | ✓ |
| WC-58 | Intermittent | ✓ | |
| WC-59 | Intermittent with Ephemeral Characteristics | ✓ | |
| WC-60 | Intermittent | ✓ | |
| WC-61 | Small Permanent with Intermittent Characteristics | ✓ | |
| WC-62 | Intermittent | ✓ | |
| WC-63 | Intermittent | ✓ | |
| WC-64 | Intermittent | ✓ | |
| WC-65 | Large Permanent | ✓ | ✓ |
| WC-66 | Intermittent | ✓ | |
| WC-67 | Intermittent | ✓ | |
| WC-68 | Intermittent | ✓ | |
| WC-69 | Large Permanent | ✓ | ✓ |
| WC-70 | Intermittent | ✓ | ✓ |
| WC-71 | Intermittent | ✓ | ✓ |
| WC-72 | Small Permanent | ✓ | ✓ |
| WC-74 | Intermittent | ✓ | |

## 2.5 Survey Dates

Primary survey work for fish habitat surveys was conducted between August 15 and 30, 2016 and between May 8 and June 7, 2018. Fish sampling (i.e., electrofishing) was conducted between June 11 and June 28, 2018. Wood turtle habitat suitability surveys were conducted in conjunction with the aquatics program between August 15 and August 30, 2016.

Wood turtle visual encounter surveys were conducted between October 3 and October 6, 2016, as the Project start date occurred after the spring survey window. Additional VES surveys were completed in spring between May 16th and May 26th, 2017.

# CHAPTER 3 RESULTS

A total of 170 watercourses were assessed for fish habitat quality in the Study Area along Highway 104 during the 2016 and 2018 aquatics programs (Appendix E, Figure 1). The majority of the Study Area is adjacent to the existing Highway 104. Consequently, the natural environment experienced some level of disturbance inherent with this development type. The approximately 10 km of new four-lane highway between Barneys River Station and James River, however, deviates from the existing Highway and is overall in more pristine condition.

Observed anthropogenic interactions with watercourses included:

- Residential and commercial development;
- Roads, driveways, and existing water crossings;
- Agricultural operations;
- Powerline corridors;
- Forestry operations;
- Illegal dumping; and
- ATV trails.

The James River has been identified in the ACCDC database as containing the 'Imperiled' (S2) Southern Gulf of St. Lawrence Atlantic salmon population. An additional 8 watercourses have been confirmed or predicted to have resident Atlantic salmon populations by DFO (LeBlanc, S. pers comm., 2017), including:

- West Branch French River;
- East Branch French River;
- Browning Brook;
- Baxter Brook;
- McIver Brook;
- Middle Brook;
- Hartshorn Brook; and
- West Barneys River.

The West River (Antigonish County), its tributaries (i.e., James River and Hartshorn Brook) and its estuary have also been designated a 'Special Trout Management Area' to enhance the local recreational fishery (MacMillan and Madden, 2007). The Highway 104 alignment does not currently interact with the

West River directly, but does cross the James River, Hartshorn Brook, and number tributaries to Hartshorn Brook.

Fish habitat quality was assessed on each of the 170 watercourses identified within the Study Area. Potential wood turtle habitat was assessed on 20 watercourses. VES for wood turtles were completed on 8 of the 20 watercourses assessed (Appendix E, Figure 1).

## 3.1 Watercourse Summary for Fish Habitat

Of the 170 watercourses assessed in the Study Area during the 2016 and 2018 field programs, the majority were classified as 'intermittent with ephemeral characteristics' (81), followed by 'intermittent' (32) and 'ephemeral' (25). The remainder were classified as 'small permanent' (14), 'small permanent with intermittent characteristics' (9) and 'large permanent' (9). Further details on these watercourses are provided in the 'Fish Habitat Fact Sheets' in Appendix F.

Assessment results from both the 2016 and 2018 field programs indicated that the majority (84%) of the permanent watercourses provided overall habitat functions for salmonids which ranged between 'moderate' and 'good' (i.e., 'moderate', 'moderate-good', and 'good'). Many of these watercourses provided adequate percentages of suitable substrate for spawning (i.e., small and large gravel), moderate to abundant quantities of instream cover, deep pools, good flow, and optimal water quality results (Figure 3.1, Figure 3.2 and Figure 3.3, respectively). Many intermittent watercourses may provide rearing habitat for salmonids at mid to high water stages; however, spawning and overwintering habitat

**Figure 3.1 Suitable substrate and flow for spawning salmonids. Potential redds observed on a tributary to Sutherlands River (WC-4-75; south side of Highway 104)**

for these are typically rated as ‘poor’ due to inadequate substrate and lack of deep pools for overwintering. Ephemeral watercourses were often dominated by fine substrates and had no defined channels, banks, or beds, and were thus not considered suitable for salmonids (Raleigh, 1982). A detailed review of the fish habitat assessments conducted in 2016 and 2018, and photographs of associated watercourses, are presented in Appendix F.

**Figure 3.2 Abundant instream cover for juvenile salmonids including large rock, undercut banks, and overhanging riparian vegetation. Looking along WC-4-23**

**Figure 3.3 A riffle-run-flat sequence providing well oxygenated water along a tributary to Sutherland’s River (WC-4-75; north side of Highway 104)**

### 3.1.1 *Habitat Quality*

A summary of habitat quality for each of the 170 watercourses assessed, and photographs of key features, are provided in the 'Fish Habitat Factsheets' (Appendix F). A summary table is provided in Appendix G. A brief overview of each watercourse found to provide 'Moderate to Good' or 'Good' overall habitat quality is described below and is also summarized in Appendix G. Wood turtle information was incorporated into the watercourse overviews if a wood turtle assessment was also conducted on the watercourse. Detailed information on wood turtle habitat quality is provided in Section 3.8. Electrofishing was not conducted on many of these watercourses as they were assumed to contain fish (see Section 2.2.2).

**WC-09 (West Branch – French River)**

The West Branch French River is a large permanent watercourse found in the community of French River, Nova Scotia. This watercourse is a west branch of the French River; its confluences with the French River is over 5 km north of the Study Area. Average channel width was 15.11 m, average wetted width was 10.57 m, and average water depth was 0.27 m. Dissolved oxygen, pH levels, and temperature were within the optimal range for brook trout. WC-09 was assessed as providing 'Good' overall fish habitat quality. The watercourse provided good rearing habitat as there was moderate to abundant instream cover for juvenile fish, including deep poles, undercut banks, woody debris and boulders. Spawning habitat was 'Good', as the channel had an adequate, constant water flow and was dominated by gravels and cobble, which are important features for spawning. Deep pools were abundant, indicating that the watercourse provided 'Good' overwintering habitat. Pool depths were measured during a mid-flow period, indicating potential year-round habitat for salmonids. During the assessment of this watercourse, over 20 juvenile and adult brook trout were observed. Fish sampling has been completed within the French River and the East Branch of the French River with confirmation of both juvenile and adult Atlantic salmon presence (LeBlanc, S. pers comm., 2017). The salmon stock within this watershed is considered small and vulnerable to disturbance or over-exploitation (Breau et al., 2009).

Various habitat features that could potentially serve as overwintering and nesting habitat for wood turtles were also identified along the West Branch French River (see Section 3.8.1).

**WC-13 (Browning Brook)**

Browning Brook is a small permanent watercourse that flows into the East Branch French River (WC-21), approximately 850 m north of the Study Area. Average channel width was 3.53 m, average wetted width was 3.33 m, and average water depth was 0.25 m. Dissolved oxygen and pH levels were within the optimal range for brook trout, and temperature was within the tolerance range for brook trout. This watercourse was found to provide 'Good' overall fish habitat quality. Spawning habitat was rated as 'Good', as the substrate was predominantly small and large gravel, mixed with cobbles and boulders. There was fast moving water with riffle habitat, which are important zones for foraging. Rearing habitat was assessed as 'Good', as there were moderate to abundant instream cover, including boulders, overhanging vegetation, undercut banks, boulders and wood debris. During the assessment, there were no deep pools > 50 cm, a general requirement for overwintering habitat. During mid to high water levels, in conjunction with swift moving waters and larger substrate, this watercourse would likely remain open during winter, providing year-round habitat for salmonids and 'Moderate' overwintering potential. No fish were observed during the habitat assessment completed by CBCL. Atlantic salmon have been identified in the East Branch French River, thus salmon may inhabit Browning Brook (LeBlanc, S. pers comm., 2017).

**WC-21 (East Branch French River)**

The East Branch French River is a large permanent watercourse found in the community of Broadway, Nova Scotia. The average bank-full channel width of the river was 8.18 m, the average wetted width was 7.22 m, and the average water depth was 0.27 m. Water quality parameters for dissolved oxygen and pH were within the optimal range for brook trout. Temperature was within the tolerance range for brook trout. Instream cover was moderate to abundant, and included woody debris, boulders, deep pools, and undercut banks. These features would provide 'Good' rearing habitat for fish. Many juvenile fish were observed during the assessment by CBCL, although species were not identified. Spawning habitat was rated as 'Good', as the substrate was free of fine materials and was dominated by gravels and cobble. Overwintering habitat was assessed as 'Good', since features necessary to provide overwintering habitat, including deep pools and constant flowing water, were observed. Overall habitat was therefore rated as 'Good' in WC-21. Signs of beaver activity (e.g., chew) were observed along WC-21. Beaver dams were not observed within the Study area. Electrofishing was conducted by DFO in 2008 and confirmed juvenile and adult Atlantic salmon presence (LeBlanc, S. pers comm., 2017).

**WC-22**

WC-22 is a small permanent watercourse that flows into the East Branch of the French River (WC-21), located in Broadway, Nova Scotia. WC-22 has an average channel width of 2.85 m, average wetted width of 1.78 m, and average water depth of 0.12 m. The watercourse meanders outside of the Study Area for approximately 200 m before intersecting with WC-21. Overall habitat quality observed in WC-22 was 'Good'. Optimal water quality parameters (DO, pH, temperature) for brook trout were recorded at the time of assessment. 'Good' spawning habitat was noted, as WC-22 contains abundant small and large gravel substrate suitable for spawning, and a constant flow to oxygenate eggs. Rearing habitat was also 'Good' as riffles and moderate amounts of in-stream cover, including boulders, overhanging vegetation, woody debris, and undercut banks, were observed. Overwintering habitat quality was assessed as 'Moderate'. While there was a constant flow, trace amounts of deep pools were observed, so some sections of WC-22 may be susceptible to freezing. Open water potential for fish was high; both juvenile and adult fish were observed at the time of assessment by CBCL, but the species were not identified. Since Atlantic salmon have been identified in the East Branch French River, there is potential for salmon to occur in WC-2-22.

**WC-23**

WC-23 is a small permanent watercourse located in the community of Broadway, Nova Scotia. WC-23 connects to the East Branch of the French River approximately 2 km northeast of the assessed area. The majority of WC-23, which was assessed within the Study Area, runs parallel to the existing highway 104. An ephemeral section is present at the east end of WC-23, where a portion of the watercourse runs through a wetland (marsh). The average channel width measured for WC-23 during fish habitat assessments conducted by CBCL was 2.73 m; average wetted width was 1.85 m, and average depth was 0.16 m. Water quality parameters for DO and pH were within the optimal range for brook trout at the time of assessment. Temperature was within the tolerance range for brook trout. Watercourse conditions were suitable for spawning, as it had adequate flow and was dominated by gravel substrate. Riffles and moderate to abundant instream cover (i.e., overhanging vegetation, woody debris, undercut banks, and instream vegetation) would provide suitable foraging and rearing habitat for juvenile fish. Adequate water flow and the presence of several deep pools would provide potential overwintering habitat for fish. WC-23 contained suitable features for spawning, rearing, and overwintering habitat quality for these life history events. Overall habitat quality was assessed as ‘Moderate-Good’, owing to the shallow water level and the fact that the watercourse passes through a wetland, which may act as a partial fish barrier due to insufficient flow and depth. Since Atlantic salmon have been identified in the East Branch French River, there is potential for salmon to occur in WC-2-23.

**WC-29 (West Barneys River)**

West Barneys River is a large permanent watercourse located in the community of Kenzieville, Nova Scotia. WC-29 is a tributary to Barneys River; the confluence is located over 4 km north of the Study Area. Average channel width of WC-29 was measured at 11.14 m, average wetted width was 5.24 m, and average water depth was 0.24 m. Overall habitat quality for West Barneys River was rated as ‘Good’. Water quality parameters, such as temperature and pH, were within the tolerance range for brook trout, while DO was within the optimal range for brook trout. Spawning habitat in West Barneys River was ‘Good’, owing to the high percentages of small and large gravel, constant water flow and optimal levels of dissolved oxygen. Instream cover was not abundant, but there was an adequate mixture of morphological features (e.g., deep pools greater than 1 m, riffles, runs, and rapids) to provide opportunities for foraging and cover. Rearing habitat quality was, therefore, rated as ‘Good’. Overwintering habitat quality was ‘Good’, as the presence of deep pools and adequate flow suggests that WC-29 will not completely freeze during winter months. Fish were observed by CBCL during fish habitat assessments, but the species were not identified. However, juvenile and adult Atlantic salmon have been confirmed in both tributaries to West Barneys River during electrofishing which had been completed by DFO multiple times over a 15-year period (LeBlanc, S. pers comm. 2017).

Potential wood turtle overwintering, nesting, and basking sites were observed along West Barneys River (see Section 3.8.2).

**WC-33 (Middle Brook)**

Middle Brook is a large permanent watercourse that confluences with Barneys River approximately 2 km north of the Study Area. Middle Brook is located in the community of Barneys River, Nova Scotia. Middle Brook had an average channel width of 12.35 m, average wetted width of 7.31 m, and average water depth of 0.25 m. Middle Brook provided ‘Good’ overall habitat quality for salmonids. Dissolved oxygen, pH, and temperature were in the optimal range for brook trout. Spawning habitat quality was assessed as ‘Good’ due to the presence of ideal spawning substrate (large and small gravel), constant flow, and high levels of dissolved oxygen. Rearing habitat quality was ‘Good’, as moderate to abundant instream cover (i.e., boulders, overhanging vegetation, woody debris, undercut banks, and deep pools), riffles and constant flow were observed. Fish were observed during the fish habitat assessment completed by CBCL, however the species could not be identified. Electrofishing conducted by DFO in Barneys River have confirmed the presence of adult and juvenile Atlantic salmon. Although no fish sampling data was available for Middle Brook, Atlantic salmon may inhabit this watercourse as it connects to Barneys River (Leblanc, S. pers comm., 2017).

**WC-40 (McIver Brook – 1)**

McIver Brook is a small permanent watercourse that connects to Middle Brook near the community of Barneys River Station, Nova Scotia. The watercourse flowed in an irregular meandering pattern parallel to Highway 104 and weaved in and out of the Study Area. The average channel width was 3.96 m, average wetted width was 2.30 m, and average water depth was 0.16 m. Water parameters for pH and DO measured at WC-40 were within the optimal range for brook trout, while water temperature was within the tolerance range for brook trout. The overall habitat quality for salmonids was assessed as 'Good'. There was an abundance of suitable substrate, good water flow and dissolved oxygen which indicates 'Good' spawning habitat. There were moderate amounts of instream cover and riffle habitat for foraging juveniles. Deep pools were not abundant but were noted along WC-40; when considered in conjunction with adequate water flow, WC-40 may not completely freeze during winter months and was assessed as having 'Moderate-Good' overwintering habitat. Salmonids (brook trout) were observed in WC-40 at the time of assessment. Similar to Middle Brook (WC-33), it was predicted that Atlantic salmon may inhabit this watercourse (LeBlanc, S. pers comm., 2017).

**WC-41**

WC-41 is a tributary to McIver Brook near the community of Barneys River Station, Nova Scotia. It is an intermittent watercourse with ephemeral sections upstream which present a partial barrier to fish, due to insufficient water depth and flow necessary for passage. This portion of the watercourse may only be accessible during periods of high flow. At the time of assessment, water levels were low in WC-41. Average channel width for WC-41 was 1.21 m, average wetted width was 0.72 m, and average depth was 0.60 m. Measurements for pH and temperature taken at the time of assessment were within the tolerance range for brook trout. The overall habitat quality for salmonids in WC-41 was assessed as 'Good'. Spawning habitat quality was assessed as 'Good', as the gravel-dominated substrate comprised the watercourse and water flow was adequate. Rearing habitat was assessed as 'Good' due to the presence of riffles and instream cover, such as undercut banks, woody debris, and overhanging vegetation. Deep pools were not abundant along WC-41, however the few that were observed and the constant water flow may provide 'Moderate-Good' overwintering habitat quality. Fish species were observed in WC-41 at the time of assessment, however the species could not be identified.

**WC-43 (McIver Brook – 2)**

WC-43 is a section of McIver brook which is closer to the headwaters. WC-43 is classified as a small permanent watercourse with intermittent characteristics. The watercourse flowed in an irregular meandering pattern, weaving in and out of the Study Area. The average channel width was 1.76 m, the average wetted width was 1.20 m, and the average water depth was 0.12 m. Water quality parameters for pH, DO, and temperature were all within the optimal range for brook trout. Spawning habitat was assessed as 'Good' owing to adequate water flow, optimal dissolved oxygen levels and substrate dominated by gravels. Rearing habitat quality was 'Good', as good flow, riffles, and moderate to abundant amounts of instream cover (overhanging vegetation, woody debris, undercut banks) were observed. Juvenile fish were also observed during the time of assessment. While deep pools were noted along WC-43, they were not abundant. As such, overwintering habitat was rated as 'Moderate'. WC-43 appeared to be a productive stream as many juvenile and adult fish were observed during the assessment. As such, overall habitat quality was rated as 'Good' for WC-43. Similar to WC-40, it was predicted that Atlantic salmon may inhabit this watercourse (LeBlanc, S. pers comm., 2017).

**WC-50 (Baxter Brook)**
Baxter Brook is a small permanent watercourse that confluences downstream with Barneys River, near Marshy Hope, Nova Scotia. Average channel width for Baxter Brook was 3.14 m, average wetted width was 2.25 m, and average depth was 0.15 m. Dissolved oxygen and pH measured at the time of assessment were within the optimal range for brook trout. Temperature was within the tolerance range for brook trout. Overall habitat quality for Baxter Brook was assessed as ‘Good’. Small and large gravel-dominated the substrate, with lower levels of fines, cobble, and boulders. The gravel substrate, swift flowing water, and optimal dissolved oxygen levels would provide ‘Good’ spawning habitat for salmonids. Moderate amounts of instream cover (overhanging vegetation, woody debris, and undercut banks), good flow, and riffles would provide ‘Good’ rearing habitat for juvenile fish. Juvenile fish were observed, but the species could not be determined. The watercourse was relatively shallow and only one deep pool greater than 50 cm was observed along the watercourse. Due to the potential for deep pools during periods of high flow, and the constant water flow observed during fish habitat assessments, overwintering habitat quality was rated as ‘Moderate’. As previously discussed, electrofishing conducted by DFO in Barneys River has confirmed the presence of adult and juvenile salmon within this watercourse. Although no DFO fish sampling data was available for Baxter Brook, it is predicted that Atlantic salmon could inhabit this watercourse as it connects to Barneys River (Leblanc, S. pers comm., 2017).

Wood turtle habitat was assessed and potential overwintering habitat was observed along Baxter Brook. However, basking and nesting areas were not observed. Overall, the watercourse was not considered to be suitable wood turtle habitat (see Table 3.6).

**WC-57 (Hartshorn Brook – 1)**
WC-57 is a portion of Hartshorn Brook, located within the proposed area in the community of Glen Bard, Nova Scotia (Appendix E, Figure 1: Page 3). Moving east, the watercourse flowed parallel to the proposed corridor and crossed the corridor on one other occasion and connects to WC-65. WC-57 had an average channel width of 3.75 m, average wetted width of 2.1 m, and an average depth of 0.09 m. Water quality parameters, such as dissolved oxygen and pH, were in the optimal range for brook trout. Temperature was within the tolerance range for brook trout at the time of assessment. Spawning habitat quality for WC-57 was assessed as ‘Good’, owing to constant water flow, substrate dominated by small and large gravels, and optimal levels of dissolved oxygen. Rearing habitat quality was ‘Good’, as the watercourse contained moderate to abundant levels of instream cover, riffles for foraging, and juvenile fish were observed throughout the reach, but were not identified to species level. Overwintering habitat was also ‘Good’ owing to the presence of abundant deep pools, good water flow, and high levels of dissolved oxygen, which would likely prevent WC-57 from freezing entirely to the bottom in these areas. Therefore, this watercourse would likely support salmonids during all seasons and life stages, and overall habitat quality was assessed as ‘Good’. Although no fish sampling data was available for WC-57, Atlantic salmon may inhabit Hartshorn Brook (Leblanc, S. pers comm., 2017).

Potential wood turtle habitat features were identified along WC-57. Overwintering habitat was observed, but nesting habitat was limited in this section of Hartshorn Brook (see Section 3.8.2).

**WC-65 (Hartshorn Brook – 2)**

This portion of Hartshorn Brook is classified as a large permanent watercourse located near the community of James River, Nova Scotia. Average channel width was 6.25 m, average wetted width was 3.83 m, and average depth was 0.15 m. Water quality parameters, such as temperature, pH, and dissolved oxygen, were within the optimal range for brook trout. Spawning habitat quality was assessed as 'Good', owing to the gravel-dominated substrate and good water flow in WC-65. Rearing habitat quality was assessed as 'Good', as there are moderate to abundant levels of instream cover to support juveniles, including overhanging vegetation, woody debris, undercut banks, deep pools and boulder. Deep pools with good water flow could provide 'Good' overwintering habitat. WC-65 would likely support salmonids year-round, therefore overall habitat quality was assessed as 'Good'. During fish habitat assessments completed by CBCL, both juvenile and adult fish were observed in WC-65, however the species were not identified.

Hartshorn Brook is a tributary to West River, with the confluence over 5 km southeast of the Study Area. Adult and juvenile Atlantic salmon have been identified in West River and its tributaries (i.e., Ohio River and Beaver River Branch). Although fish sampling data was not available for Hartshorn Brook, it is predicted that Atlantic salmon may inhabit this watercourse as it connects to the West River (Leblanc, S. pers comm., 2017).

WC-65 was also assessed for suitable wood turtle habitat. Potential basking sites, as well as overwintering and nesting habitats, were observed along this section of Hartshorn Brook (see Section 3.8.2).

**WC-69 (James River)**

The James River is a large permanent watercourse located within the community of the James River, Nova Scotia. Average channel width was 22.76 m, average wetted width was 8.62 m, and average depth was 0.21 m. Water quality parameters for dissolved oxygen and temperature were within the optimal range for brook trout, while pH (8.03) was just above the optimal maximum of 8.0. Spawning was assessed as 'Good', owing to the high percentage of small and large gravel substrate; adequate, constant flow would prevent silt from building up in spawning locations. Rearing habitat was 'Good', as there were riffles for foraging, as well as an abundance of boulders and moderate levels of undercut banks that would provide cover for juveniles. Overwintering habitat quality was 'Good', as there were multiple deep pools over 50 cm, constant flow, and optimal dissolved oxygen levels. These watercourse features would likely sustain salmonid populations in all seasons. As such, the overall habitat quality for the James River was assessed as 'Good'.

Sections of the James River have been degraded by human activity (i.e., channel straightening, dam and reservoir creation, and altered riparian zones), which has limited habitat availability for salmonids; stream restoration work, including the installation of digger logs, have been conducted in the past to restore habitat function (Goff, 1999). However, Atlantic salmon have been identified in the James River through the ACCDC and NSDNR Significant Habitat database. James River is also known for its resident population of Brown trout (*Salmo trutta*) (pers. comm. Antigonish Town and County Rivers Association, 2017). Fish were observed during the fish habitat assessment, although the species could not be distinguished.

Potential wood turtle nesting and overwintering habitat was observed along the James River at the time of assessment. High risk habitat (agricultural fields) was also observed within a large portion of the riparian habitat (see Section 3.8.2).

**WC-72 (Pushies Brook)**
WC-72 is a small permanent watercourse located in the community of Brierly Brook, Nova Scotia. Average channel width of WC-72 was 1.95 m, average wetted width was 1.63 m, and average depth was 0.31 m. Water parameters, such as dissolved oxygen and temperature were within the optimal range for brook trout, and pH was within the tolerance range for brook trout. WC-72 had adequate flow and good depth. Although gravels comprised approximately 35% of the substrate, the substrate was dominated by fines, which could potentially smother salmonid eggs. As such, spawning habitat for WC-72 was assessed as 'Moderate'. Riffles and moderate to abundant instream cover (i.e., overhanging vegetation, undercut banks, and small woody debris) were observed. Due to the large amount of fines in WC-72, rearing habitat was assessed as 'Moderate-Good'. Overwintering habitat was also 'Moderate-Good'. The presence of good flow and several deep pools greater than 50 cm make it unlikely that the watercourse would freeze completely during winter months and may support salmonids year round. A salmonid was observed in WC-72 at the time of assessment.

Pushies Brook was also assessed for wood turtle habitat; potential nesting or overwintering habitat was not observed, however suitable stream characteristics were observed along Pushies Brook (Section 3.8.2).

**WC-75 (Russell Brook)**
WC-75 (Russell Brook) is a large permanent watercourse located in the community of Sutherlands River, Nova Scotia. Average channel width was 10.94 m, average wetted width was 6.87 m, and average water depth was 0.24 m. Water quality parameters for pH and temperature were within the tolerance range for brook trout, while dissolved oxygen levels was within the optimal range. Russell Brook had a good and constant flow, as well as substrate containing gravels. Potential redds were also observed (Figure 3.1). Spawning habitat was therefore assessed as 'Good'. Moderate to abundant instream cover (i.e., overhanging vegetation, undercut banks), good depth, riffles, multiple deep pools, as well as pools with snyes would provide 'Good' rearing habitat for salmonids. Overwintering habitat was also assessed as 'Good' due to the presence of deep pools and constant flow, which would prevent the watercourse from freezing completely during winter months. Juvenile and adult Atlantic salmon have been identified in Sutherlands River (Breau, 2013; Biron and Breau, 2015). Atlantic salmon were also caught and identified during the fish sampling component of the aquatics program (see Section 3.3). Habitat conditions observed along Russell Brook during the habitat assessment suggest that this watercourse may support salmonids year round.

**WC-85**
WC-85 is a large permanent watercourse (Tributary to French River) located in the community of French River, Nova Scotia. Average channel width was 5.65 m, average wetted width was 5.03 m, and average depth was 0.56 m. The presence of beaver dams along this watercourse resulted in some flooding, although the presence of these dams was not anticipated to impede fish passage. Water quality parameters for temperature and dissolved oxygen measured at the time of assessment were within the optimal range for brook trout; pH was within the tolerance range for brook trout. Overall habitat quality

for WC-85 was assessed as ‘Moderate-Good’ for salmonids. Water flow in WC-85 was adequate, but substrate was dominated by fines (90%). Spawning habitat was, therefore, assessed as ‘Poor-Moderate’. Rearing habitat was rated as ‘Good’, owing to good water depth, riffles for foraging, and moderate to abundant instream cover for juveniles. Overwintering habitat was assessed as ‘Good’ owing to the presence of deep pools along its reach, good water flow, and optimal levels of dissolved oxygen. Fish were observed at the time of assessment, although the species was not identified. Potential for fish presence in WC-85 was therefore rated as ‘High’ for all seasons. Both Atlantic salmon and brook trout were caught and identified in WC-85 during the fish sampling portion of the aquatics program (see Section 3.3).

**WC-90**

WC-90 was a long contiguous watercourse located in the community of French River, Nova Scotia. Due to its length, the watercourse was divided into two separate assessments (WC-90-A and WC-90-B; see’ Fish Habitat Facts Sheets’ in Appendix F). The section classified as WC-90-B was ephemeral and would not provide fish habitat. The section classified as WC-90-A originated in an ephemeral section through a wetland before transitioning into an intermittent watercourse. The ephemeral section of WC-90-A would not provide fish habitat, however the intermittent section was assessed as providing ‘Moderate-Good’ overall habitat quality for salmonids. This intermittent section had an average channel width of 1.45 m, an average wetted width of 0.98 m, and an average depth of 0.14 m. Water quality parameters, specifically pH and temperature, were within the tolerance range for brook trout. Dissolved oxygen levels were within the optimal range for brook trout. The intermittent section was dominated by gravel substrate and had adequate water flow. It was, therefore, assessed as having ‘Good’ spawning habitat. It contained moderate to abundant instream cover (e.g., overhanging vegetation, woody debris, instream vegetation) which would provide cover for juvenile fish and riffles for foraging. Rearing habitat was, therefore, assessed as ‘Good’. Overwintering habitat was rated as ‘Poor-Moderate’ due to low water levels and the absence of deep pools; however, there was adequate flow, which may reduce the probability of the watercourse freezing completely in deeper areas. Small waterfalls were observed along this watercourse, although they would not pose a barrier to fish passage as they were less than 50 cm in height from plunging pools. A juvenile fish was observed during the fish sampling program; this species was likely a brook trout, but could not be confirmed as no fish were successfully caught while electrofishing this watercourse (see Section 3.3). Due to this observation, potential for fish in open water was considered ‘High’ during the aquatics field program but considered ‘Low’ during frozen conditions.

**WC-95-B (Anderson Brook)**

WC-95-B is part of Anderson Brook which runs parallel along Highway 104 and intersects with West Barneys River (WC-29) downstream. WC-95-B is located in the community of Kenzieville, Nova Scotia. WC-95-B is a large permanent watercourse with an average channel width of 7.21 m, an average wetted width of 3.85 m, and an average depth of 0.17 m. Water quality parameters for pH, dissolved oxygen, and temperature were within the optimal range for brook trout. WC-95-B had many braided sections and large dry channels were observed at the time of assessment. Spawning habitat was rated as ‘Moderate’. Water flow was adequate, and substrate was composed mainly of cobbles (50%), followed by gravels (35%). Moderate to abundant instream cover (i.e., wood debris and undercut banks) would provide cover for juveniles, while riffles would provide foraging opportunities. As such, rearing habitat was rated as ‘Good’. Overwintering habitat was assessed as ‘Moderate’. WC-95-B had good flow and pools throughout; however, pools were not deeper than 50 cm, suggesting that some sections may freeze during winter. Overall, habitat quality for WC-95-B was rated as ‘Moderate-Good’. No fish were observed during fish habitat assessments conducted by CBCL. However, salmonids were caught in WC-95-A during the fish sampling program. WC-95-A is also part of Anderson Brook. Coupled with the fact that Anderson Brook intersects with West Barneys River (WC-29), there is potential for salmonids to occur in WC-95-B as well.

## 3.2 Significant Watercourses

Salmon populations in zone 18A of the Gulf of St. Lawrence are more stable and larger than many of the other salmon populations around the province (DFO, 2012). Atlantic salmon within this population are considered a species of conservation concern and have been assigned an S-rank of S2 (Imperiled) by the ACCDC and a designation of ‘Special Concern’ by COSEWIC. Watercourses that contain significant habitat for Atlantic salmon are indicated below.

### *3.2.1 Significant Watercourses – Atlantic Salmon*

A review of the ACCDC and the NSDNR significant habitat database revealed that the James River contained significant habitat for the southern Gulf of St. Lawrence population of Atlantic salmon population (ACCDC, 2015, 2018). During the fish habitat assessments conducted on the James River (WC-69), the watercourse was assessed as having attributes that would support the lifecycle (i.e., spawning, rearing, overwintering) of Atlantic salmon.

## 3.3 Fish Sampling

A total of 49 watercourses were electrofished in the Study Area during the fish sampling program. Of the 49 watercourses electrofished, fish were caught in 37 watercourses (Appendix H). A total of 8 fish species were captured and confirmed within the Study Area during the electrofishing program (Table 3.1). Four (4) were CRA fish species, and 4 were CRA support species. Two (2) SOCC were confirmed within the Study Area, including Atlantic salmon and brook trout. Atlantic salmon were captured in 3 watercourses, while brook trout were caught in 33 watercourses. Atlantic salmon were found in a secondary tributary to the French River, in a primary tributary to the Barneys River and a primary tributary to the Sutherlands River (Appendix E, Figure 2). Brown trout, although not native to Nova Scotia, are a CRA fish species and were captured in 6 watercourses. Data collected on all fish species captured and a list of confirmed fish bearing watercourses are provided in Appendix H. Pictures of each fish species caught are provided in Appendix I.

**Table 3.1 Fish Species Identified During the 2018 Electrofishing Program**

| Common Name | SOCC | CRA Species | CRA Support Species | Number of Individuals | Number of Watercourses |
|---|---|---|---|---|---|
| Atlantic Salmon | X | X | | 10 | 3 |
| Brook Trout | X | X | | 143 | 33 |
| Brown Trout | | X | | 8 | 6 |
| White Sucker | | X | | 1 | 1 |
| Northern Redbelly Dace | | | X | 14 | 3 |
| Creek Chub | | | X | 8 | 2 |
| Threespine Stickleback | | | X | 36 | 4 |
| Ninespine Stickleback | | | X | 1 | 1 |

During the fish sampling program, Atlantic salmon and brown trout were both found to occur in 2 watercourses within the Study Area, including Russel Brook and a primary tributary to the French River. Based on this, it is foreseeable that brown trout and Atlantic salmon are also potentially present in some of the large and small permanent watercourses assumed to have Atlantic salmon throughout the Study Area (see Appendix E, Figure 2). Considering this, there is a small potential for Atlantic salmon and brown trout hybrids to occur in these watercourses. Brown trout in both their native and introduced habitat are known to rarely hybridize with Atlantic salmon (McGowan and Davidson, 1992). Though information on this cross in Nova Scotia is limited, information does exist in Newfoundland. Rivers sampled on the Avalon Peninsula in Newfoundland were found to have a regional parr hybrid frequency of 4.67% with local river frequencies ranged from 0.00 to 18.75% (McGowan and Davidson, 1992). Typically the cross occurs between a female brown trout and male Atlantic salmon. Differences in viability between the reciprocal crosses has been purposed to be a factor (Herke et al., 1990). It is suspected that male Atlantic salmon stay in the spawning stream after the female Atlantic salmon has left to return to the ocean. This leaves an abundance of male Atlantic salmon in the present of brown trout females (Greeley, 1932; Webb and Hawkins, 1989). Spawning male Atlantic salmon are on average larger then spawning male brown trout. As both species spawn in the same fashion, with males guarding the females from rivals, the larger male Atlantic salmon have a competitive advantage over the smaller male brown trout and may chase them away from brown trout female (O'Connell, 1982). Male Atlantic salmon can also reach sexually maturity as parr (Gjerde, 1984), while this is unlikely to happen in brown trout. This can put mature male Atlantic salmon parr in the spawning river at the same time as mature female brown trout (O'Connell, 1982). The fish sampling program did not confirm any Atlantic salmon brown trout hybrids. Atlantic salmon - brown trout parr hybrids are extremely difficult to confirm via visual inspection as they can resemble either species (Jones, 1948; Nyman, 1970). Protein electrophoresis and mitochondrial DNA analysis has been an effective way to test for hybrids (McGowan and Davidson, 1992).

## 3.4 Fish Bearing Watercourses

In total, 128 of 170 watercourses were identified as having potential for fish at some point during the year within the Study Area. Fifty-two (52) of the 170 watercourses were confirmed to be fish bearing within the Study Area according to the following criteria (Appendix E, Figure 2):

- Fish caught or observed during the 2018 electrofishing program;
- Incidental fish observed during the 2016 and/or 2018 fish and fish habitat assessments; and
- Permanent named watercourses where fish presence is assumed (e.g., French River, James River, etc.).

If watercourses did not meet the above criteria, they were not sampled. The remaining 76 watercourses have the potential to contain fish at some point during the year. Potential for fish in these watercourses would be highest during non-frozen conditions, during spring run-off and immediately following a heavy rainfall event. Forty-two (42) watercourses had no potential for fish within the Study Area.

Although 170 watercourses were identified within the Study Area, only 127 of these watercourses were identified in the Project Area (Table 3.2). Forty-five (45) of the identified watercourses within the Project Area were confirmed to contain fish and an additional 55 watercourses have the potential for fish at some point during the year. In summary, a total of 100 watercourses have the potential for fish at some point during the year which leaves 27 watercourses with no potential or habitat for fish.

**Table 3.2 Watercourse Summary by Fish Habitat Potential within the Study Area and PA**

| Fish and Fish Habitat Status | Study Area | Project Area |
|---|---|---|
| Total Watercourses | 170 | 127 |
| Confirmed Fish Bearing | 52 | 45 |
| Potential for Fish* | 76 | 55 |
| No fish habitat | 42 | 27 |

** These are in addition to the Confirmed Fish-bearing Watercourses.*

## 3.5 Water Quality

The Study Area for the Highway 104 Twinning Project falls within two separate watersheds. Watercourses in the eastern third of the Project Area fall within the South River and West River primary watershed (Table 3.3). The majority of the Study Area falls within the French River, Barneys River, and West River secondary watersheds (Appendix E, Figure 3). All the watercourses occurring within the Study Area are summarized in Table 3.3. All surface water within the Study Area eventually drains into the Gulf of St. Lawrence.

The western portion of the Highway 104 Twinning Project Study Area occurs within the South River and West River primary watershed, which is composed of three secondary watersheds, the West River, Rights River, and South River secondary watersheds. Of these three, the Study Area falls only within the West River secondary watershed (Appendix E, Figure 3). The West River secondary watershed drains northwards towards the Gulf of St. Lawrence. A total of 47 watercourses occur within this secondary watershed, of which only 9 are considered to be permanent (Table 3.3). These are James River, West Branch French River, Browning Brook, Middle Brook, McIver Brook, Baxter Brook, Hartshorn Brook, East Branch French River, and West Barneys River. The majority of watercourses within these watersheds are unnamed streams or surface drainage flows.

**Table 3.3 Summary of Watercourses within the Highway 104 Twinning Study Area, By Watershed**

| Primary Watershed | Secondary Watershed | Watercourse Size Category | Name and Number within Study Area |
|---|---|---|---|
| **French River** | **Barneys River** | Ephemeral | 10 |
| | | Intermittent | 12 |
| | | Intermittent, Ephemeral | 41 |
| | | Large Permanent | 3 |
| | | Small Permanent | 5 |
| | | Small Permanent, Intermittent | 2 |
| | **French River** | Ephemeral | 4 |
| | | Intermittent | 5 |
| | | Intermittent, Ephemeral | 17 |
| | | Large Permanent | 3 |
| | | Small Permanent | 6 |
| | | Small Permanent, Intermittent | 3 |
| | **Russel Brook** | Ephemeral | 4 |
| | | Intermittent | 1 |
| | | Intermittent, Ephemeral | 1 |
| | | Large Permanent | 1 |
| | **Shore Direct** | Ephemeral | 2 |
| | | Intermittent | 2 |
| | | Intermittent, Ephemeral | 1 |
| **South River and West River** | **West River** | Ephemeral | 5 |
| | | Intermittent | 12 |
| | | Intermittent, Ephemeral | 21 |
| | | Large Permanent | 2 |
| | | Small Permanent | 3 |
| | | Small Permanent, Intermittent | 4 |
| | | **Grand Total** | **170** |

Watercourses located within the central and western portions of the Study Area are part of the French River primary watershed which is composed of 12 secondary watersheds (Appendix E, Figure 3). Of these, only 4 are actually located wholly or partially within the Study Area. These are the Russell Brook, French River, and Barneys River secondary watersheds, as well as a small unnamed coastal secondary watershed labelled as 'Shore Direct' (Appendix E, Figure 3). A summary of each is provided below:

- The Russell Brook secondary watershed drains north into the southern extent of Merigomish Harbour. It encompasses one permanent watercourse (Russell Brook), and 7 ephemeral to intermittent watercourses (Appendix E, Figure 3). The Study Area intersects Russell Brook twice shortly before it flows into the Harbour (Appendix E, Figure 3);

- The Barneys River secondary watershed is drained by 73 watercourses, of which 10 are considered permanent (Table 3.3). This secondary watershed flows northward into Merigomish Harbour at Lower Barneys River (Appendix E, Figure 3);
- The French River secondary watershed contains 38 watercourses, of which 12 are considered permanent (Table 3.3). This secondary watershed flows north into Merigomish Harbour (Appendix E, Figure 3); and
- A small unnamed small secondary watershed (labeled as Shore Direct) also drains northward into the upper reaches of Merigomish Harbour (Appendix E, Figure 3). The Project Study Area crosses this watershed approximately 5 km south of the Harbour. The portion of this secondary watershed that intersects the Study Area contains no watercourses considered to be permanent (Table 3.3).

It should be noted that the Sutherlands River secondary watershed is also part of the French River primary watershed, but its eastern boundary meets the western boundary of the Study Area and no portion of the Sutherland River secondary watershed actually occurs within the Project Area (Appendix E, Figure 3).

In 2016 and 2018, the CBCL team assessed and sampled for water quality in a total of 170 watercourses within the Study Area, ranging from large permanent rivers to small ephemeral watercourses. These are summarized by watershed and size category in Table 3.3. All watercourses sampled for water quality are depicted in Appendix E, Figure 1. A complete review of water parameter results is included in Appendix J, along with applicable CCME FWAL guidelines (pH and DO only). Brief summaries of the water quality parameters listed in Appendix J and are provided below by parameter.

*Velocity:* Velocity values were generally variable, which is not surprising, given the range of watercourse sizes observed (Appendix J). Recorded values ranged from 0 to 0.91 m/s, with an average velocity of 0.25 m/s.

*pH:* The majority (64 of 87, or 73.5%) of the watercourses measured in 2016 and 2018 had pH readings within the 'suitable' range for aquatic life per CCME guidelines. The balance of watercourses were acidic, ranging from 4.28 – 6.47. Overall, pH values ranged from 4.19 to 8.79, with an average value of 6.91. Water quality results indicated that pH levels were within the tolerance range for brook trout; however, 37 watercourses were outside of the optimal range for brook trout (Raleigh, 1982) (Appendix J).

*Temperature:* The average value of the 96 temperatures readings recorded at watercourses within the Study Area in 2016 and 2018 was 12.01$^{o}$C, with values ranging from 6.16 to 18.94$^{o}$C. Water quality results indicated that temperature values were within the tolerance range for brook trout; however, 47 watercourses were outside of the optimal range for brook trout (Raleigh, 1982) (Appendix J).

*Conductivity:* Conductivity values were generally variable, which is to be expected, given the range of watercourse sizes and flow velocities observed (Appendix J). Recorded values (n=96) ranged from 0.05 to 1437 µS/cm, with an average conductivity value of 193.6 µS/cm. There are no CCME guidelines for conductivity values for freshwater aquatic life.

*Turbidity:* Turbidity values were generally variable, which is to be expected, given the range of watercourse sizes and flow velocities observed (Appendix J). Recorded values (*n*=68) ranged from 0 to 8.4 NTU, with an average turbidity value of 1.29 NTU. The turbidity values collected during the aquatic sampling programs could be used for comparison purposes if future turbidity monitoring is required during watercourse crossing installations. The CCME guidelines for turbidity state maximum increases above background levels for freshwater aquatic life as follows (CCME, 1999):

- "Clear Flow: Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period); and
- High flow or turbid waters: Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is > 80 NTUs."

*Total Dissolved Solids (TDS):* The average value of the 93 TDS readings recorded at watercourses in 2016 and 2018 was 0.14 g/L, with values ranging from 0.02 to 1.14 g/L (Appendix J). There are no CCME guidelines for total dissolved solid values for freshwater aquatic life.

*Dissolved Oxygen:* Dissolved oxygen levels were generally variable, which is to be expected, given the range of watercourse sizes and flow velocities observed (Appendix J). Recorded values ranged from 0.69 to 18.00 mg/L, with an average dissolved oxygen reading of 9.60 mg/L. The CCME guideline for Freshwater Aquatic Life for dissolved oxygen cites a minimum acceptable dissolved oxygen concentration of 9.5 mg/L for early life stages for cold-water biota, and a concentration of 6.5 mg/L for other life stages (CCME, 1999). Of the 89 watercourses for which DO was measured, 79 (89%) met the minimum guideline of 6.5 mg/L, and 50 (56%) also met the guideline of 9.5 mg/L for early life stages. A total of 83 watercourses (93%) met the tolerance value of 5 mg/L for brook trout (Raleigh, 1982). At the time of assessment, five (5) watercourses had DO levels below the tolerance limit for brook trout. These watercourses and their DO levels at the time of assessment are outlined in Table 3.4.

**Table 3.4 Watercourses with Dissolved Oxygen Levels Below the Tolerance Limit for Brook Trout**

| *Watercourse ID* | *Watercourse Type* | *DO (mg/L)* | *Brook Trout Tolerance (Raleigh, 1982)* |
|---|---|---|---|
| WC-04-01 | Ephemeral | 1.52 | Tolerance: ≥ 5.0 |
| WC-04-02 | Intermittent, Ephemeral | 1.41 | |
| WC-04-06 | Intermittent | 0.69 | |
| WC-04-08 | Intermittent | 3.75 | |
| WC-04-44 | Intermittent, Ephemeral | 3.90 | |

## 3.6 Natural and Anthropogenic Impedances or Impacts to Fish

Various impedances to fish passage and potential impacts to fish habitat quality were identified within the Study Area. These included inflow drops, outflow drops, steep gradient barriers, dry sections and unconsolidated flow, ATV trails, agriculture, woody debris jams, and beaver activity. A summary is provided in the sections below.

### *3.6.1 Inflow Drop*

An inflow drop occurs when a culvert is improperly installed causing the upstream substrate to sit higher than the bottom of the upstream end of the culvert (Figure 3.4). Inflow drops often cause more of an impedance to fish movement than outflow drops. This is because culverts often have hard bottoms made of manufactured materials such as concrete or lumber, therefore, no plunge pools are present for fish to gain velocity or to "jump" at a proper angle to clear the inflow drop (Nichols and McGirr, 2005).

**Figure 3.4 Inflow Drop on WC-68.**

### *3.6.2 Outflow Drop*

An outflow drop occurs when a culvert is improperly installed causing water to fall from its outflow and dig out a plunge pool (Figure 3.5). Although plunge pools are sometimes considered useful habitat (as they are often the deepest pool in the reach), they may create a partial barrier over time. As the pool digs itself deeper, the distance between the culvert outlet and the surface of the water becomes greater, possibly rendering it only passible in times of high water, or not at all (Nichols and McGirr, 2005).

**Figure 3.5 Outflow drop along WC-58.**

### *3.6.3 Dry Sections and Unconsolidated Flow*

Dry sections or unconsolidated flow can cause an impedance to fish passage and render upstream habitat inaccessible (Figure 3.6). Unconsolidated flow occurs during low water periods, in areas with oversized substrate, areas that experience dewatering, and in channels that have been widened. Although these areas are not completely dry, water is spread throughout the channel with no defined thalweg or consolidated section of flow for fish to navigate (Nichols and McGirr, 2005). Dry sections or areas with unconsolidated flow were encountered throughout the Study Area.

**Figure 3.6 Unconsolidated flow along WC-47.**

### *3.6.4 Debris Jams*

Debris jams occur when large and small woody debris, as well as discarded man-made materials, gather at a common location along a watercourse (Figure 3.7). As the debris accumulates, it can create a barrier to fish passage and possibly cause channel braiding if the jam is established long enough (Booth et al., 1997). Debris jams were identified on several watercourses throughout the Study Area (Figure 3.7). In addition, there were several observations for potential debris jams to develop in the future due to dense alder swales and downed timber.

**Figure 3.7 A debris jam along WC-8-68.**

### *3.6.5 Beaver Dams*

Beaver dams can both enhance and degrade habitat depending upon the size of the dam and where it is located within the watershed (Figure 3.8; Figure 3.9). Dams may hold water in an area which can create deeper, larger pools in the upstream habitat, but they may also hinder the ability of fish to access habitat above or below the dam if it blocks flow entirely (Kambietz, 2003). Beaver dams and lodges commonly cause debris jams if destroyed during times of high flow. The materials flow downstream until it catches and begins to accumulate, eventually causing a potential full barrier to fish passage.

**Figure 3.8 Beaver chew.**

**Figure 3.9 Beaver activity within Study Area.**

### 3.6.6 ATV Trails

Many trails for all-terrain vehicles (ATV) are found near highway 104 and in the corridor area (Figure 3.10). Frequent observations were made of ATV trails intersecting with watercourses or wetlands. ATVs can cause bank erosion, release silt into the water, contaminate water with petroleum products, alter existing substrate, and account for vegetation loss (Alberta Environment & Parks, 2016). If operated in-stream, ATVs can also negatively impact salmonid redds, or other important habitat structures within watercourses. ATV stream crossings are typically found in shallow, riffle habitats (with hard substrates) which corresponds with preferred salmonid spawning areas. ATVS can also be a vector for invasive or alien species which can impact the ecological integrity of aquatic environments (Marion 2006).

**Figure 3.10 ATV trail within WC-69 (James River) floodplain.**

### 3.6.7 Steep Gradients

A steep gradient barrier is considered an area where the slope of the channel is too steep for fish species to navigate further upstream (Figure 3.11). The Oregon Department of Forestry characterize these barriers as (Robison et al., 2000):

- Natural falls and chutes > 8' for salmon; >4' for resident trout;
- Channel steepness (with pools) >20% over a distance of 30' for adult salmon; 20% over a distance of 20' for resident trout; and
- Channel steepness (without pools) >12% over a distance of >30' for adult salmon; >12% over a distance of >20' for resident trout.

Watercourses with steep gradients were often observed to have oversized substrate (i.e., large cobble and boulder) that can render flow unconsolidated in times of low water. Watercourses with a steep gradient can be susceptible to becoming dry during summer months or have increased water velocity during high flows. Both conditions can limit fish passage (USDA, 1991). Salmonids have the ability to increase their swimming speed for one to six seconds, which is commonly referred to as darting or burst speed (Thompson, 2013). These bursts allow salmonids to manoeuvre over waterfalls or chutes, or traverse through areas with steep gradients or high water velocity. Salmonid darting speeds cannot be sustained for an extended periods, so features such as pools are required to conserve energy for salmonids to successfully clear these obstacles (Barber et al., 2009).

**Figure 3.11 Steep gradient along WC-84.**

### *3.6.8 Agriculture*

The deterioration of the riparian buffer and the introduction of crops or livestock can increase water temperature, destabilize banks and increase erosion, cause sediment buildup and reduce pool/riffle habitat, and increase nutrient loads due to chemical use or livestock waste. Livestock crossings are often found in shallow riffle sections of a watercourse which are also the preferred spawning habitat for salmonids (Dieleman, 2012). A potential livestock crossing was observed in a shallow portion of the James River (Figure 3.12), however this potential crossing was outside the Study area. An agricultural field adjacent to a watercourse, as evident along the James River can result in sedimentation into the watercourse, and the introduction of pesticides and chemicals used on agricultural fields into adjacent watercourses. A decrease in benthic macroinvertebrate biodiversity has been observed in areas with increased nutrient levels due to agricultural practises (Hepp et al., 2010). Algae blooms have been linked to agricultural runoff, which in some cases result in a marked decrease in dissolved oxygen leading to fish kills (Dieleman, 2012).

**Figure 3.12 Agriculture operation along the banks of WC-69 (James River).**

## 3.7 CRA Fisheries

Pursuant to Section 35 (1) of the *Fisheries Act*, "*no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery*". A 'commercial fish' is defined under the Act as a species that "*is harvested under the authority of a licence for the purpose of sale, trade or barter*". A 'recreational fish' refers to a species that "*is harvested under the authority of a licence for personal use of the fish or for sport*", and an 'Aboriginal fish' is a species that "*is harvested by an Aboriginal organization or any of its members for the purpose of using the fish as food, for social or ceremonial purposes or for purposes set out in a land claims agreement entered into with the Aboriginal organization.*" A support fish (or prey species) is defined as a species that contributes to the productivity of a CRA fishery (DFO, 2013).

Correspondence with DFO has indicated that commercial, recreational, and Aboriginal fishing ventures occur near or within Study Area, including American eel, Atlantic salmon, trout, smelt, and gaspereau licences (Hudson, J. pers comm., 2017; Dwyer, A. pers comm., 2017). The following are licenses distributed near or within the Study Area:

- Commercial American eel licenses;
- Commercial gaspereau licenses;
- Aboriginal commercial/communal licenses for gaspereau and American eel;
- Food, social, and ceremonial Aboriginal licenses for Atlantic salmon, American eel, striped bass, and trout; and
- Recreational licenses for Atlantic salmon and trout.

The nature of these fisheries/agreements allow license holders to use various methods to collect fish (i.e., pots, dip nets, and fyke nets) in different locations. Tributaries with high catch rates are targeted, but can vary from year to year.

After a review of available information, a total of 13 CRA species and 7 potential support species were identified as probable residents within the Study Area (Table 3.5). None of the probable resident species (whether CRA or support species) are federally or provincially protected under the *Species at Risk Act* (SARA) or *Nova Scotia Endangered Species Act* (NSESA), respectively. Five (5) probable residents are classified as species of conservation concern (SOCC) and have been assigned an S-Rank between S2 and S3 by the ACCDC. Three (3) of these species have been ranked by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

During the fish sampling program, 4 CRA fish species and 4 CRA support species were confirmed within the Study Area; 2 of the CRA fish species identified are SOCC (Table 3.5). Habitat requirements of CRA fish species and SOCC identified in Table 3.5 are provided in the species descriptions in Section 3.7.1.

Spawning times for each of the CRA fish species and support species assumed or confirmed within the Study Area are provided in Appendix K. The time of year when eggs and fry are in the substrate are also provided in Appendix K. Atlantic salmon, brook trout and brown trout all typically start spawning in the fall with eggs occurring in the substrate until hatching in the spring. Most of the other identified species typically spawn in the spring with eggs staying in the substrate for only several weeks. American eel adults will leave freshwater streams sometime between August and September and spawn in the Sargasso Sea (see Appendix K).

**Table 3.5 Probable and Confirmed Fish Species within the Study Area**

| Common Name | Scientific Name | S-Rank | S-Rank Description | COSEWIC | CRA Fisheries | Species Identified in 2018 |
|---|---|---|---|---|---|---|
| American Eel | *Anguilla rostrata* | S2 | Imperiled | Threatened | C, R, A | |
| Atlantic Salmon* | *Salmo salar* | S1 | Critically Imperiled | Special Concern | R, A | X |
| Brook Trout | *Salvelinus fontinalis* | S3 | Vulnerable | -- | R, A | X |
| Brown Trout | *Salmo trutta* | SNA | Not Assessed | -- | R | X |
| Rainbow Trout | *Oncorhynchus mykiss* | SNA | Not Assessed | -- | R | |
| Gaspereau (Alewife) | *Alosa pseudoharengus* | S3 | Vulnerable | -- | C, R, A | |
| Rainbow Smelt | *Osmerus mordax* | S5 | Secure | -- | C, R, A | |
| White Sucker | *Catostomus commersonii* | S5 | Secure | -- | C, R, A | X |
| Yellow Perch | *Perca flavescens* | S5 | Secure | -- | R | |
| White Perch | *Morone americana* | S5 | Secure | -- | R | |
| Striped Bass* | *Morone saxatilis* | S2S3N** | Vulnerable to Imperiled | Special Concern | A | |
| Smallmouth Bass | *Micropterus dolomieu* | SNA | Not Assessed | -- | R | |
| Brown Bullhead | *Ameiurus nebulosus* | S5 | Secure | -- | R | |
| Blacknose Dace | *Notropis heterolepis* | S4 | Apparently Secure | -- | Support Species | |

| Common Name | Scientific Name | S-Rank | S-Rank Description | COSEWIC | CRA Fisheries | Species Identified in 2018 |
|---|---|---|---|---|---|---|
| Northern Redbelly Dace | *Phoxinus eos* | S5 | Secure | -- | Support Species | X |
| Golden Shiner | *Notemigonus crysoleucas* | S4 | Apparently Secure | -- | Support Species | |
| Banded Killifish | *Fundulus diaphanus* | S5 | Secure | -- | Support Species | |
| Creek Chub | *Semotilus atromaculatus* | S5 | Secure | -- | Support Species | X |
| Threespine Stickleback | *Gasterosteus aculeatus* | S5 | Secure | -- | Support Species | X |
| Ninespine Stickleback | *Pungitius pungitius* | S5 | Secure | -- | Support Species | X |

* Southern Gulf of St. Lawrence population
** The "N" denotes a non-breeding population

### *3.7.1 Species Descriptions*

**Atlantic salmon (*Salmo salar*)**

The Gulf of St. Lawrence population of Atlantic salmon are an anadromous species designated as 'Special Concern' by COSEWIC in 2010 (COSEWIC, 2018a) and assigned an S-Rank of S1 ('Critically Imperiled') by ACCDC in 2017 (ACCDC, 2018b). Atlantic salmon spend part of their life feeding and growing during long migrations at sea and then returning to reproduce in their natal freshwater streams. Spawning Atlantic salmon move upriver from spring through fall. Spawning occurs from October to November usually in gravelly substrates near the head of riffles, or the tail of a pool. Young salmon parr usually live in shallow riffle areas that have gravel, cobble, or boulder bottoms (Page et al., 1991). Spawned out adults immediately return to sea or overwinter in freshwater until returning to sea in spring. The preferred freshwater habitats for each life stage of Atlantic salmon are riffles and pools with high percentages of pebble and gravel substrate. A review of the ACCDC database revealed a population and potential significant habitat for Atlantic salmon along James River. The West River and its tributaries (which includes James River) are well known Atlantic salmon habitat, and one of the last remaining strongholds for the species in Nova Scotia (DFO, 2012). As indicated in Section 3.5, Atlantic salmon were found in 3 watercourses within the Study Area during the 2018 fish sampling program.

**Brook trout (*Salvelinus fontinalis*)**

Brook trout are ranked as S3 ('Vulnerable') by ACCDC in 2015 (ACCDC, 2018b). Brook trout require a year-round supply of cold, clear water, as well as plenty of cover from overhanging branches, logs and rocks. Streams with cool, quiet pools between runs of fast water and rapids are typical habitat, as are clear, cold lakes and beaver ponds (OMNR, 2011). It is a carnivorous species, feeding on insects, leeches, small fish, mollusks, frogs and salamanders (Mi'kmaw Conservation Group, 2018). Spawning occurs in fall within stream riffle habitats, where the female deposits fertilized eggs in a depression she excavates in the gravel substrate (Scott and Scott, 1988). During winter, trout seek shelter from freezing and ice within deep pools, ponds, lakes, around instream debris and undercut banks (Huusko et al., 2007). Brook trout are able to tolerate pH levels between 4.0 and 9.5. Brook trout thrive in water with dissolved oxygen (DO) levels greater than 7 mg/L and temperatures less than 15°C. An anadromous population of brook trout is well known in Antigonish Harbour and its main riverine inputs: the North, South, West and

Wrights rivers and their tributaries (i.e., James River; Spares et al., 2014). As indicated in Section 3.5, brook trout were found in 33 watercourses within the Study Area during the 2018 fish sampling program.

**American eel (*Anguilla rostrata*)**

The American eel is designated as 'Threatened' by COSEWIC (COSEWIC, 2012) and was assigned an S-Rank of S2 ('Imperiled') by ACCDC (ACCDC, 2018b). American eels spawn in the Sargasso Sea, which is located within the Atlantic Ocean. Nursery areas can be located in salt or freshwater. Adults typically overwinter in muddy bottoms in bays and estuarine habitats. American eels prefer shallow, protected waters, and rock, sand, mud, woody debris and aquatic vegetation for cover. Eelgrass and interstitial spaces are also important for cover. They forage on fish, molluscs, crustaceans, insect larvae, surface-dwelling insects, worms, and plants (COSEWIC, 2012). American eel have been known to tolerate DO levels as low as 4 mg/L (Rulifson et al., 2004) and pH as low as 4.0 (Reynolds, 2011). American eel has supported major CRA fisheries and is important both culturally and historically to Aboriginal groups and communities across Canada (COSEWIC, 2012). American eel were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Striped bass (*Morone saxatilis*)**

Striped bass are a semi-anadromous species that occurs naturally along most of the eastern seaboard of North America (Bain and Bain, 1982). The southern Gulf of St. Lawrence population has been designated as 'Special Concern' by COSEWIC (COSEWIC, 2018b) and assigned an S-Rank of S2S3 (Imperiled to Vulnerable) by ACCDC (ACCDC, 2018b). Striped bass spend most of their life in marine environments, with spawning occurring in fresh or brackish water (Bain and Bain, 1982). Eggs and larvae drift in the pelagic zone with juveniles feeding on benthic macro-invertebrates and zooplankton. Adult striped bass diet consists mainly of soft-rayed fishes. Striped bass avoid areas with temperatures above 25°C. In the lab, juveniles acclimated to 5.0°C in estuarine salinities (5-30 ppt) survived a gradual temperature decrease of 2.3°C day-1 to sub-zero temperatures (Hurst and Conover, 2002). However, the lower lethal temperature for juveniles acclimated to 15.0°C in fresh water is 2.4°C (Cook et al., 2006). Juveniles overwintering in brackish water (13-18 salinity) preferred 4oC to 5°C (Buhariwalla et al., 2016). Adults utilize a broader thermal range of 6.5°C to 28.0°C during summer foraging (Nelson et al., 2010) and have been recorded overwintering in temperatures of 1.2°C to 7.5°C (Buhariwalla et al., 2016). Striped bass prefer well-oxygenated water with >44% DO. Successful spawning occurs in areas with a velocity of 0.3 m/s or greater, temperatures between 17°C to 19°C and total dissolved solids less than <0.18 ppt. Juvenile striped bass stay near shore and gradually venture further into areas with higher salinity. Striped bass are rarely observed further than six to eight km from shore. (Bain and Bain., 1982) and forage within non-natal estuaries throughout the summer before overwintering in estuaries and rivers (Hogans and Melvin, 1984; Bradford et al., 1998; Douglas et al., 2003, 2009). Striped bass were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Alewife/Gaspereau (*Alosa pseudoharengus)***

Alewife is an anadromous species ranked as S3 ('Vulnerable') by ACCDC (ACCDC, 2018b). The alewife spends a large portion of its lifecycle in marine environments, re-entering fresh water in spring for spawning. Juvenile alewife rely on benthic macro-invertebrates as their main food source, while adults prey on small fish as well as macro-invertebrates. Alewife home to their native streams primarily during the day with spawning occurring on rocky substrate in shallow lakes or in low flow river pools with gentle flow and submerged vegetation (Scott and Scott, 1988). The preferred temperature range for alewife spawning is between 10.5°C and 26°C. Eggs are considered extremely tolerant of elevated total dissolved solids and salinity in aquatic environments (Pardue, 1983). Adults return to the sea shortly after spawning, and often return to spawn for one or more years following first-time spawning during their lifespan. Alewife are considered a species of importance for Aboriginal communities and culture (Natural History, 2016). Alewife are fished commercially, and were an important economic factor during colonial times. Although current harvests are much lower, the fishery still exists throughout the Maritime Provinces (DFO, 2001). Alewife were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Rainbow trout (*Oncorhynchus mykiss*)**
Rainbow trout are ranked as SNA (not assessed) by ACCDC. They were introduced in Nova Scotia in the early 1900s as a sport fish. Due to rainbow trout being more sensitive to acidic waters then other salmonids, they are unable to reproduce throughout most of the province. They feed on aquatic invertebrates and surface feed on flies, fish, and fish eggs (NWF, 2017). Rainbow trout are capable of tolerating higher temperatures (lethal temperature is approximately 27°C) but prefer a temperature range between 7°C and 18°C (COSEWIC, 2014). This tolerance to high temperatures, when compared to other salmonids, has made rainbow trout a more viable lake stocking option than other salmonids (NSDFA, 2005). As such, they are stocked for recreational fisheries and are managed in aquaculture operations (NSDFA, 2005). Rainbow trout were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Brown trout (*Salmo trutta*)**
Brown trout are native to Europe and were introduced in the Americas during the latter part of the 19th century. Brown trout have been assigned an S-Rank of SNA by ACCDC (ACCDC, 2018b). Upon reaching a length greater than 25 cm, trout change their diet consisting mainly of terrestrial insects and benthic macro invertebrates to fish and crustaceans. Adult brown trout are active night feeders, and prefer alewife for prey. Brown trout home to their natal streams in the fall to spawn, with a preference substrate free of fines or silt, a constant water flow, and temperatures between 6 to 12°C (Raleigh et al., 1986). Brown trout prefer watercourses with riffle and pool dominated habitat, with at least 15 cm of water depth and a velocity of approximately 0.15 m/sec. Unlike brook trout, brown trout usually inhabit the lower, less steep sections of streams where nutrients are often more abundant. Brown trout can tolerate pH ranges between 5.0 and 9.5 but will avoid areas with less than 5 mg/L of dissolved oxygen. (Raleigh et al., 1986). As indicated in Section 3.5, brown trout were found in 6 watercourses within the Study Area during the 2018 fish sampling program.

**White sucker *(Catostomus commersonii*)**
White sucker is ranked as S5 ('Secure') by ACCDC (ACCDC, 2018b). White suckers are found in lakes and rivers throughout Canada (DFO, 2010). These bottom-feeders prefer a diet of benthic macro-invertebrates in both juvenile and adult life stages. Spawning occurs in the spring or early summer in inlets and outlets of lakes, or in gravel dominant riffle habitat of streams. A swift flow (0.4-0.9 m/sec) is preferred for spawning with an acceptable hatching temperature of 11 to 16°C. The preferred habitat type for adults is deep pools (>50 cm depth) with abundant in-stream and riparian cover. The minimum dissolved oxygen level that white sucker are known to tolerate is 4.3 mg/L, with no discernible upper

limit. The habitable temperature range is between 1 and 32°C (Twomey, 1984). White sucker is considered a commercial and Aboriginal fishery in some regions (Cooke and Murchie, 2013). White suckers are also fished recreationally and are commonly used as bait fish (NSSA, 2005). As indicated in Section 3.5, white sucker was found in 1 watercourse within the Study Area during the 2018 fish sampling program.

**Rainbow smelt (*Osmerus mordax)***

Rainbow smelt are ranked as S5 ('Secure') by ACCDC (ACCDC, 2018b). Rainbow smelt are an anadromous species with some landlocked populations. They are a schooling fish and inhabit pelagic zones of oceans and lakes. Smelt prefer deep, cold waters with pH levels greater than 6 (Evans and Loftus, 1987). Spawning occurs in swift moving riffles or runs of rivers in April and May after the ice melt, with water temperatures between 4 and 9°C (Buckley, 1989). Their adhesive eggs are released into the current and immediately stick to whatever substrate they contact. Afterwards, spawning adults return to the ocean where they spend the summer feeding. Rainbow smelt are highly sensitive to increasing temperatures and salinities, hence any increase in these conditions could have negative effects on reproduction and survival of larvae (Unanian and Soin, 1963). Smelt are fished commercially using hoop nets, and recreationally by dip-netting and jigging with hooks through the ice in estuaries where anadromous populations overwinter (CRI, 2014; Spares et al., 2014). Rainbow smelt were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Brown bullhead** (***Ameiurus nebulosus***)

Brown bullhead is ranked as S5 ('Secure') by ACCDC (ACCDC, 2018b). Brown bullheads are found in pools and sluggish runs of slow moving rivers and lakes (Scott and Crossman, 1973; Minnesota DNR, 2016). They prefer warm shallow water with a soft bottom. They are tolerant of acidic waters, low oxygen levels, high levels of $CO_2$, as well as turbid or muddy/murky waters, and consequently have few predators able to withstand these conditions (Dehring and Krueger, 2008). Brown bullheads ability to hibernate and survive winterkill along with its tolerant behaviour make them able to inhabit almost any type of aquatic environment. They are nocturnal species and feed on aquatic invertebrates including mollusks, insects, other fish, fish eggs, algae and plants (Minnesota DNR, 2016). Upon reaching sexual maturity brown bullheads spawn between April and July during water temperatures of 21-26$^{o}$C. Females lay their eggs in a mud nest sheltered by a mat of vegetation or a log. Once the eggs hatch and develop into fry, they form protective schools (Minnesota DNR, 2016). Brown bullhead were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Smallmouth bass** (***Micropterus dolomieui***)

Smallmouth bass, a non-native species in Nova Scotia, has been assigned an S-Rank of 'SNA' (Not Assessed) by ACCDC (ACCDC, 2018b). Smallmouth bass prefer cool mid order streams with good flow, abundant shade and alternating deep pools and riffles (Edwards et al., 1983).They prefer to live in larger waterbodies (>10.5 m wide) that consist of rocks, fallen trees and crevices that provide cover (Scott and Crossman, 1973). Adult and juvenile smallmouth bass feed on fish, insects and arthropods. Spawning occurs in mid-April to July in shallow depths (1 - 2.5 m) with large substrate (>30 mm) along protected coves or shore lines (Clancey, 1980; Watson, 1955; Henderson and Foster, 1957). They typically nest in sites with gravel substrate, some type of cover, and warmer (13-35°C) temperatures (Scott and Crossman, 1973). Adults prefer deep pools (<12 m deep) and shaded areas with cooler waters. In the early stages, smallmouth bass are highly sensitive to cooler temperatures and rising water levels.

Smallmouth bass can tolerate turbidity but excessive turbidity and siltation will have negative effects upon the population (Coutant, 1975). The inhabitable or lethal pH level for smallmouth bass is 3.0 while optimal pH levels are between 7.9 and 8.1 (Butler, 1972). They require >6 mg/L dissolved oxygen for growth and cannot survive once oxygen levels drop near 1 mg/L (Buckley, 1975). Smallmouth bass were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**Yellow perch** (***Perca flavescens***)
Yellow perch have been assigned an S-Rank of S5 ('Secure') by ACCDC (ACCDC, 2018b). Yellow perch are a schooling fish found in both fresh and salt water (10.3-13 salinity) however they require fresh water for spawning (Scott and Crossman, 1973). Yellow Perch typically inhabit lakes and ponds, but can also reside in low to moderate velocity rivers and streams that are dominated by aquatic vegetation and soft gravel bottoms (Kitchell, 1977). They also inhabit large fresh water lakes and ponds (1-10 m depth) or live along the shore of brackish waters near floating docks and other structures. The greatest number of yellow perch occur in clear water with low turbidity (Scott and Crossman, 1973). Yellow perch favor areas with at least 25% vegetative cover for spawning (Krieger et al., 1983). Yellow perch prefer temperatures of 17.6-25°C, with upper lethal limits approached in temperatures >26°C (Krieger et al., 1983). Spawning occurs in spring when temperatures are between 6.7-12.8°C. Yellow Perch are quite tolerant of low dissolved oxygen concentrations, however levels between 0.2-1.5 mg/L during winter may be lethal. They are relatively tolerant of low pH, but levels <5.5 may negatively affect reproduction (Ryan and Harvey, 1979). Yellow perch were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

**White perch (*Morone americana*)**
White perch are ranked as S5 ('Secure') by ACCDC (ACCDC, 2018b). White perch are a semi-anadromous species related to striped bass. Spawning takes place in lakes, rivers and estuaries between April and May (Stanley and Danie, 1983). White perch can spawn in water with salinity as high as 4.2. Silt does not affect developing eggs until it reaches a level of 500 mg/L. Larvae swim up and down in a vertical motion, relying on flow and velocity to help them drift along (Stanley and Danie, 1983). Juvenile white perch inhabit streams with mud/silt substrates and prefer an abundance of in-stream vegetation. White perch fry diets consists of mostly zooplankton, while juveniles primarily forage on benthic macro invertebrates and crustaceans. Once the adult stage is reached, their diet consists almost exclusively of fish and they are known to be cannibalistic. White perch can withstand temperatures between 2 and 32.5°C while spawning occurs between 12 and 14°C. An adult can withstand pH ranges between 6.0 and 9.0 in freshwater (Stanley and Danie, 1983). White perch were not detected during the sampling program in 2018, but have the potential to occur within the Study Area.

## 3.8 Wood Turtle Habitat Summary

In 2016, a total of 20 watercourses were surveyed to assess potential wood turtle habitat (see Table 2.3 andTable 3.7). Of the watercourses surveyed, 6 were 'permanent' watercourses (2 'large permanent', 3 'small permanent', and 1 'small permanent with intermittent characteristics') and 14 were 'intermittent' watercourses (13 'intermittent' and 1 'intermittent with ephemeral characteristics'). Each watercourse assessed had low to medium overstory and understory densities. Surveyed watercourses were also within 100 m of what have been identified as 'high risk habitats'. High risk habitats are areas where

turtles (if present) could be at risk of being injured or killed by machinery (e.g., due to roads, ATV trails, and agricultural fields). Surveyors observed potential nesting areas along 3 of the surveyed watercourses. Potential overwintering sites were observed along 17 of the watercourses surveyed.
In May of 2017, based on recommendation from the previous year's studies and incorporating further habitat quality observations collected during fish studies in the watercourses, full VES (two or more surveys) were conducted on 11 watercourses within the Study Area. No wood turtles were observed along any of the watercourses in 2016 or 2017, however potential nesting and overwintering sites were identified along most watercourses.

### *3.8.1 Habitat Quality*

Results from the wood turtle habitat assessments are summarized in Table 3.6. Descriptions for watercourses containing potential wood turtle habitat that were recommended for VES are provided in Section 3.8.2.

Table 3.6 Summary of Wood Turtle Habitat Assessment Results for Watercourses Assessed within the Study Area

| Primary Watershed Name | Secondary Watershed Name | Watercourse Name | Watercourse ID | Watercourse Type | Overstory Density | Understory Density | Sunlit Opening (within 50 m) | High Risk Habitats Present | Basking Sites | Foraging Potential | Nesting Areas | Over-Wintering Sites | Suitable Stream Characteristics | Further wood turtle survey recommended |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| French River | Barneys River Watershed | Baxter Brook | WC-50 | Small Permanent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | Yes | No | No |
| French River | Barneys River Watershed | Unnamed | WC-55 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | No | No | No |
| South/West River | West River Watershed | Unnamed | WC-56 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Hartshorn Brook (1) | WC-57 | Small Permanent | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | Possible | Yes | Yes | Yes |
| South/West River | West River Watershed | Unnamed | WC-58 | Intermittent | Medium (20-80%) | Medium (20-80%) | Frequent | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-59 | Int. with eph. characteristics | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-60 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-61 | Small perm. with int. characteristics | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-62 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-63 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-64 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | Yes | No | No |

| *Primary Watershed Name* | *Secondary Watershed Name* | *Watercourse Name* | *Watercourse ID* | *Watercourse Type* | *Overstory Density* | *Understory Density* | *Sunlit Opening (within 50 m)* | *High Risk Habitats Present* | *Basking Sites* | *Foraging Potential* | *Nesting Areas* | *Over-Wintering Sites* | *Suitable Stream Characteristics* | *Further wood turtle survey recommended* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South/West River | West River Watershed | Hartshorn Brook (2) | WC-65 | Large Permanent | Medium (20-80%) | Medium (20-80%) | Abundant | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| South/West River | West River Watershed | Unnamed | WC-66 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | Yes | Yes | No | Yes | Yes | No |
| South/West River | West River Watershed | Unnamed | WC-67 | Intermittent | Low (2-20%) | Low (2-20%) | Frequent | Yes | Yes | Yes | No | Yes | No | No |
| South/West River | West River Watershed | Unnamed | WC-68 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | Yes | No | No |
| South/West River | West River Watershed | James River | WC-69 | Large Permanent | Low (2-20%) | Low (2-20%) | Abundant | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| South/West River | West River Watershed | Unnamed | WC-70 | Intermittent | Low (2-20%) | Medium (20-80%) | Frequent | Yes | Yes | Yes | No | Yes | Yes | Yes |
| South/West River | West River Watershed | Unnamed | WC-71 | Intermittent | Medium (20-80%) | Medium (20-80%) | Frequent | Yes | Yes | Yes | No | Yes | Yes | Yes |
| South/West River | West River Watershed | Pushies Brook | WC-72 | Small Permanent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | No | Yes | Yes |
| South/West River | West River Watershed | Unnamed | WC-74 | Intermittent | Medium (20-80%) | Medium (20-80%) | Few | Yes | No | Yes | No | No | No | No |

### 3.8.2 *Visual Encounter Survey Results*

A total of 18 watercourses were selected for VES as they potentially provide wood turtle habitat (Table 3.7). Of the 18 watercourses selected, full VES (two or more surveys) were conducted on 11 watercourses. A partial VES was conducted on 1 watercourse (WC-70) but aborted after 17 minutes due to unsuitable habitat. VES were not initiated on the remaining 6 watercourses, as these were deemed unsuitable habitat for wood turtles by CBCL Biologists upon arrival on site, and were subsequently omitted from the survey plan (Table 3.7). Results for full VES conducted by CBCL are summarized in

Table 3.8. Watercourses for which full VES (two or more surveys) were conducted are described in Section 3.8.3.

**Table 3.7 Watercourses for which VES were Selected and Completed**

| Watercourse ID | Survey Date | Round | Full VES Conducted | Survey Mins |
|---|---|---|---|---|
| WC-05* | October 5, 2016 | 1 | N | 0 |
| WC-09 | October 6, 2016 | 1 | Y | 136 |
| WC-09 | May 16, 2017 | 2 | Y | 135 |
| WC-09 | May 23, 2017 | 3 | Y | 98 |
| WC-09 | May 25, 2017 | 4 | Y | 102 |
| WC-13 | May 19, 2017 | 1 | Y | 127 |
| WC-13 | May 25, 2017 | 2 | Y | 137 |
| WC-21* | October 5, 2016 | 1 | N | 0 |
| WC-24* | October 5, 2016 | 1 | N | 0 |
| WC-26* | October 5, 2016 | 1 | N | 0 |
| WC-27* | October 5, 2016 | 1 | N | 0 |
| WC-29 | October 5, 2016 | 1 | Y | 191 |
| WC-29 | May 17, 2017 | 2 | Y | 182 |
| WC-29 | May 23, 2017 | 3 | Y | 165 |
| WC-29 | May 25, 2017 | 4 | Y | 145 |
| WC-31* | October 5, 2016 | 1 | N | 0 |
| WC-33 | May 18, 2017 | 1 | Y | 184 |
| WC-33 | May 24, 2017 | 2 | Y | 122 |
| WC-40 | May 18, 2017 | 1 | Y | 41 |
| WC-50 | May 18, 2017 | 1 | Y | 69 |
| WC-57 | October 6, 2016 | 1 | Y | 124 |
| WC-57 | May 18, 2017 | 2 | Y | 65 |
| WC-65 | October 4, 2016 | 1 | Y | 76 |
| WC-65 | May 17, 2017 | 2 | Y | 169 |
| WC-65 | May 24, 2017 | 3 | Y | 134 |
| WC-69 | October 4, 2016 | 1 | Y | 151 |
| WC-69 | May 17, 2017 | 2 | Y | 100 |
| WC-69 | May 24, 2017 | 3 | Y | 77 |
| WC-70** | October 4, 2016 | 1 | N | 17 |
| WC-71 | October 4, 2016 | 1 | Y | 100 |
| WC-72 | October 3, 2016 | 1 | Y | 300 |
| WC-72 | May 16, 2017 | 2 | Y | 249 |

* VES were not initiated as habitat conditions were deemed unsuitable upon arrival to site.

**Partial VES was conducted on WC-70 but aborted after 17 minutes due to unsuitable wood turtle habitat.

**Table 3.8 Summary of VES conducted on Watercourses within the Study Area**

| Primary Watershed Name | Secondary Watershed Name | Watercourse Name | Watercourse ID | Watercourse Type | Survey Round | Date | Survey Duration (min) | Air Temp (°C) | | Water Temp (°C) | | Wood Turtle observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Start of Survey | End of Survey | Start of Survey | End of Survey | |
| French River | French River | Unnamed Tributary | WC-05 | Small Permanent | 1 | October 5, 2016 | 52 | 26 | 27 | 14.6 | 16.2 | No |
| French River | French River | West Branch French River | WC-09 | Large Permanent | 1 | October 6, 2016 | 136 | 16 | 19 | 11.1 | 12.5 | No |
| French River | French River | West Branch French River | WC-09 | Large Permanent | 2 | May 16, 2017 | 135 | 8 | 8 | 8.2 | 8.5 | No |
| French River | French River | West Branch French River | WC-09 | Large Permanent | 3 | May 23, 2017 | 98 | 11 | 11 | 10.3 | 10.7 | No |
| French River | French River | West Branch French River | WC-09 | Large Permanent | 4 | May 25, 2017 | 102 | 9 | 10 | 12.5 | 12.6 | No |
| French River | French River | Browning Brook | WC-13 | Small Permanent | 1 | May 19, 2017 | 127 | 18 | 26 | 12.3 | 13.2 | No |
| French River | French River | Browning Brook | WC-13 | Small Permanent | 2 | May 25, 2017 | 137 | 7 | 8 | 8.9 | 12 | No |
| French River | Barneys River | West Barneys River | WC-29 | Large Permanent | 1 | October 5, 2016 | 191 | 8 | 17 | 6.7 | 9.6 | No |
| French River | Barneys River | West Barneys River | WC-29 | Large Permanent | 2 | May 17, 2017 | 182 | 18 | 18 | 12.8 | 12.3 | No |
| French River | Barneys River | West Barneys River | WC-29 | Large Permanent | 3 | May 23, 2017 | 165 | 12 | 12 | 8.8 | 9.4 | No |
| French River | Barneys River | West Barneys River | WC-29 | Large Permanent | 4 | May 25, 2017 | 145 | 4 | 6 | 8.7 | 9.7 | No |
| French River | Barneys River | Middle Brook | WC-33 | Large Permanent | 1 | May 18, 2017 | 184 | 15 | 18 | 9.6 | 11.7 | No |
| French River | Barneys River | Middle Brook | WC-33 | Large Permanent | 2 | May 24, 2017 | 122 | 11 | 13 | 9.5 | 10.5 | No |
| French River | Barneys River | McIver Brook | WC-40 | Small Permanent | 1 | May 18, 2017 | 41 | 21 | 24 | 12.8 | 11 | No |

| Primary Watershed Name | Secondary Watershed Name | Watercourse Name | Watercourse ID | Watercourse Type | Survey Round | Date | Survey Duration (min) | Air Temp (°C) | | Water Temp (°C) | | Wood Turtle observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Start of Survey | End of Survey | Start of Survey | End of Survey | |
| French River | Barneys River | Baxter Brook | WC-50 | Small Permanent | 1 | May 18, 2017 | 69 | 25 | 25 | 15.8 | 16.6 | No |
| South/West River | West River | Hartshorn Brook | WC-57 | Small Permanent | 1 | October 6, 2016 | 124 | 12 | 16 | 8.2 | 9.6 | No |
| South/West River | West River | Hartshorn Brook | WC-57 | Small Permanent | 2 | May 18, 2017 | 65 | 25 | 28 | 16.4 | 15.8 | No |
| South/West River | West River | Hartshorn Brook | WC-65 | Large Permanent | 1 | October 4, 2016 | 76 | 16 | 14 | 10.4 | 11.2 | No |
| South/West River | West River | Tributary to Hartshorn Brook | WC-65 | Large Permanent | 2 | May 17, 2017 | 169 | 11 | 16 | 10.5 | 12.9 | No |
| South/West River | West River | Tributary to Hartshorn Brook | WC-65 | Large Permanent | 3 | May 24, 2017 | 134 | 14 | 14 | 10.9 | 11.6 | No |
| South/West River | West River | James River | WC-69 | Large Permanent | 1 | October 4, 2016 | 151 | 11 | 16 | 11.3 | 13.2 | No |
| South/West River | West River | James River | WC-69 | Large Permanent | 2 | May 17, 2017 | 100 | 12 | 12 | 7.7 | 9.2 | No |
| South/West River | West River | James River | WC-69 | Large Permanent | 3 | May 24, 2017 | 77 | 16 | 16 | 11.7 | 11.5 | No |
| South/West River | West River | Unnamed | WC-71 | Intermittent | 1 | October 4, 2016 | 100 | 8 | 11 | 7.6 | 10.1 | No |
| South/West River | West River | Pushies Brook | WC-72 | Small Permanent | 1 | October 3, 2016 | 300 | 13 | 10 | 11.7 | 11.6 | No |
| South/West River | West River | Pushies Brook | WC-72 | Small Permanent | 2 | May 16, 2017 | 249 | 6 | 6 | 9.7 | 10.4 | No |

### *3.8.3 Watercourse Summary for Wood Turtle Habitat*

#### 3.8.3.1 WC-09 (French River)

The French River was not identified as a priority watershed in the watershed map created by NSDNR in 2003 (MacGregor and Elderkin, 2003). A habitat assessment was, therefore, not conducted on this watercourse. It was later identified as potentially containing suitable wood turtle habitat. Therefore, a VES was recommended and surveys were completed for the West Branch of the French River in October 2016 and May 2017.

As discussed in Section 3.1.1, the West Branch of the French River is a large permanent watercourse with an average channel width of approximately 15 m. The watercourse contains clear water with good flow. Substrate is composed predominantly of gravel and cobble. As shown in Figure 3.13 and Figure 3.14, suitable habitat features were observed during the VES; such features include large woody debris and deep pools (Figure 3.13), log jams, islands, and undercut banks, as well as sidebars (Figure 3.14). These features may serve as potential nesting and overwintering sites for wood turtles. There was evidence of previous beaver activity, but beavers do not appear to be currently active in the area assessed.

**Figure 3.13 Large woody debris and deep pool along the French River**

**Figure 3.14 Sidebars, boulders, and fallen debris along the French River.**

#### 3.8.3.2 WC-13 (Browning Brook)

Browning Brook is a small permanent watercourse that flows into the East Branch French River (WC-21) This watercourse was, on average, 1.72 m wide and contained clear waters with elevated flows and an average water of 0.18 m with occasional deep pools (0.40-0.50 m, Figure 3.15). The riparian and upland area surrounding Browning Brook consisted of immature to mature mixed-wood including eastern hemlock, poplar (*Populus spp.*), sugar maple, red maple, white ash, speckled alder (*Alnus incana*), balsam fir and red spruce regeneration. Areas of disturbance (clear and partial cuts) which are considered high-risk habitat for wood turtles were present along portions of the watercourse, north of Highway 104 (Appendix A).

No wood turtles were encountered during the VES along WC-15 in 2017, but overwintering and nesting sites were observed. Overwintering sites consisted of deep pools with undercut banks, good flow, overhanging vegetation and debris jam (Figure 3.16). The majority of possible nesting sites were considered to be of low quality because they were small in size, partially shaded, or did not contain ideal substrate.

A large side bar (Figure 3.7), approximately 900 m north of Highway 104 was identified as a potential nesting area as it was open to sunlight and composed of sand and both small and large gravels.

**Figure 3.15 WC-13 – Browning Brook watercourse profile**

**Figure 3.16 Potential overwintering site consisting of deep pools, good flow, undercut banks, debris jam and overhanging vegetation observed at WC-13.**

**Figure 3.17 Potential nesting habitat composed of sand and both large and small gravels at WC-13.**

#### 3.8.3.3 WC-29 (West Barneys River)

The West Barneys River was not initially identified in the wood turtle priority watershed habitat and, therefore, a habitat assessment was not conducted on this watercourse. It was later identified as potentially containing suitable wood turtle habitat. Therefore, a VES was recommended and was completed for West Barneys River in 2017.

During the VES, suitable overwintering, nesting, and basking sites were observed. Some habitat features observed included deep pools and sidebars (Figure 3.18). The bank adjacent to the watercourse was steep on one side, and the watercourse was confined in some areas (Figure 3.19). In some sections of the watercourse, residential lawns reached the bank of the watercourse. A side channel connected to West Barneys River was also surveyed. It contained shaded, clear water with a gentle flow, deep pools with gravel bottoms, and woody debris mats.

**Figure 3.18 A section of West Barneys River that contains sidebars and slightly undercut banks.**

**Figure 3.19 Portion of West Barneys River that is confined by a steep bank.**

#### 3.8.3.4 WC-33 (Middle Brook)

Middle Brook is a large permanent watercourse that connects to Barneys River (Figure 3.20). Wood turtle habitat assessments or VES were not completed on Middle Brook in 2016. However, during fish habitat assessments, CBCL biologists identified favorable salmonid habitat features that may also serve as suitable wood turtle habitat (e.g., small and large gravel substrate, constant water flow, occasional islands, undercut banks and overhanging vegetation). Due to the presence of these habitat features, Middle Brook was selected for a VES in spring of 2017.

During the time of the VES, bank-full streamflow conditions were observed; the watercourse is confined in some areas, with an average channel width of 12.35 m and an average depth of 0.35 m with many deep pools between 0.5-1.0 m in depth. Waters were clear with moderate instream cover, deep pools, and a swift, constant flow. Substrate was dominated by small and large gravel. The riparian and upland area along Middle Brook consisted of mature mixed-wood forest composed of red spruce, eastern hemlock and white pine on the southeast facing slope and poplar, yellow birch, American beech and sugar maple on the southwest bank of the watercourse. No wood turtles were observed during the VES, however potential overwintering habitats characterized by deep pools, woody debris, undercut banks or gentle flow (Figure 3.13) were observed. Potential nesting habitats (e.g., gravel-sand sidebars) were also observed during the VES, although many were considered to be low potential, either due to the possibility of flooding or limited sun exposure (e.g., Figure 3.14).

**Figure 3.20 Middle Brook (WC-33) profile on the south side of Highway 104.**

**Figure 3.21 Deep pool with gentle flow, large woody debris, undercut banks and overhanging vegetation, observed at Middle Brook (WC-33).**

**Figure 3.22 Gravel-sand sidebar with flood potential observed at WC-33.**

#### 3.8.3.5 WC-40 (McIver Brook)

McIver Brook is a small permanent watercourse that connects to Middle Brook near the community of Barneys River Station, Nova Scotia. McIver Brook had an average channel width of 2.36 m and contained an irregular meandering pattern. Water was clear and the water flow was elevated with an average depth of 0.20 m. The riparian and upland area along McIver Brook was hardwood dominant and consisted of yellow birch, sugar maple, striped maple (*Acer pensylvanicum*), white ash and red spruce, with red spruce and balsam fir regeneration.

In 2017, CBCL biologists terminated the VES at approximately 700 m, after deeming the watercourse and riparian area as unsuitable habitat for wood turtle. The watercourse was entrenched in some areas and overall confined and shallow (Figure 3.23), resulting in poor overwintering habitat. Additionally, no potential nesting habitat was observed. A second round of VES was not subsequently completed on McIver Brook.

**Figure 3.23 General stream characteristics of McIver Brook (WC-40).**

### 3.8.3.6 WC-50 (Baxter Brook)

Baxter Brook is a small permanent watercourse that meanders into Barneys River near Marshy Hope, Nova Scotia. The watercourse has an average channel width of 2.45 m and contains clear waters dominated by small and large gravel substrate, with lower levels of fines, cobble, and boulders. The riparian and upland area surrounding the section of Baxter Brook surveyed was dominated by mature hardwoods, such as yellow birch, sugar maple, red maple and eastern hemlock. Mature red spruce and patches of immature fir and spruce understory were also present.

Wood turtle habitat assessments or VES were not previously completed on Baxter Brook; however, during fish habitat assessments completed in 2016, CBCL biologists identified swift flowing water, moderate levels of instream cover including overhanging vegetation, and undercut banks as favorable overwintering habitat features for wood turtles.

At the time of assessments, no deep pools greater than 0.50 m were observed, but were considered possible during mid to high flows; as such, this watercourse was selected for VES during May 2017. During the VES in May 2017, only 2 potential overwintering pools greater than 0.40 m deep were observed, and waters were shallow (Figure 3.24) with an average water depth of 0.15 m. Due to a lack of suitable overwintering habitat and no observations of wood turtles or potential nesting sites, Baxter Brook was deemed as unsuitable wood turtle habitat by CBCL biologists and the VES was stopped after approximately 600 m. A second round of VES was not completed on this watercourse.


**Figure 3.24 Shallow waters lacking deep pools characterize Baxter Brook (WC-50).**

#### 3.8.3.7 WC-57 (Hartshorn Brook)

Hartshorn Brook is a small permanent watercourse located in Glen Bard, Nova Scotia (Appendix A). The riparian and upland area surrounding Hartshorn Brook is characterized by mature mixed-wood, including eastern hemlock, red maple, yellow birch, red spruce and balsam fir with a shrub dominated understory. A VES was recommended on this watercourse by CBCL biologists, due to the presence of potential overwintering and nesting sites, basking sites, foraging potential and suitable stream characteristics (i.e., good water flow and substrate dominated by small and large gravels) which were observed during habitat assessments.

During the VES conducted in May 2017, few overwintering areas were observed as waters were generally shallow with an average depth of 0.20 m. Nesting potential was poor due to either small patch size, little exposure to sunlight or high flood potential (Figure 3.25 and Figure 3.26). Since the few wood turtle habitat characteristics observed were low in quality and water levels were low, CBCL biologists ceased the VES of Hartshorn Brook at approximately 650 m and did not complete a second round of VES surveys on this watercourse.

**Figure 3.25 Shallow waters and small gravel patches with high flood potential observed at Hartshorn Brook (WC-57).**

**Figure 3.26 Woody debris (foreground), slight undercut banks, and log jam (background) along Hartshorn Brook (WC-57).**

#### 3.8.3.8 WC-65 (Tributary to Hartshorn Brook)

This portion of Hartshorn Brook was classified as a large permanent watercourse with an irregular wandering pattern. WC-65 was recommended for a VES following the wood turtle habitat assessment, as potential habitat was observed along this watercourse. WC-65 was characterized by mid flow conditions, clear water, and gravel substrate. Wood turtle basking and overwintering sites (deep pools) were observed. Various food sources were observed at low to moderate densities. Many large sidebars, islands, and other areas within the floodplain surrounding the watercourse could potentially serve as nesting habitat (Figure 3.27).

**Figure 3.27** **A sidebar observed along WC-65.**

#### 3.8.3.9 WC-69 (James River)

The James River is a large permanent watercourse with a sinuous stream pattern, low flow conditions, clear water, and substrate containing relatively even proportions of gravel, cobble, boulder and fines (Figure 3.29). Shrub floodplain is the dominant riparian habitat type and multiple high risk habitats are present within 100 m of watercourse. Food sources and basking, overwintering, and nesting sites were observed during the habitat assessment along WC-69. A VES was, subsequently, recommended for James River.

During the VES, a large portion of riparian habitat was observed to consist of agricultural land (Figure 3.30). Agricultural areas are considered 'high risk' to wood turtles due to increased predation and death rates, and reduced growth and recruitment (MacGregor and Elderkin, 2003). Based on cattle prints and manure on either side of the watercourse, cattle are moving across the watercourse on the south side of the highway. Large side bars and gravel and sand areas observed within the riparian zone, particularly on the north side of Highway 104, could serve as potential nesting habitat (Figure 3.31). Deep pools that could serve as overwintering sites were also observed along the James River.

**Figure 3.28 View of James River on the north side of Highway 104**

**Figure 3.29 Agricultural fields along the James River, south of Highway 104.**

**Figure 3.30 Potential nesting habitat observed along the James River, north of the Highway 104.**

### 3.8.3.10 WC-71

WC-71 is a narrow, intermittent, sinuous watercourse that contained low flow conditions during the 2016 habitat assessment, clear water, sand to gravel substrate, and shallow banks. The riparian habitat consists of various habitat types, but is dominated by a marsh (Figure 3.32). Upland habitat consists of forested swamp and mature softwood. Four different high risk habitats were observed within 100 m of the watercourse, and agricultural fields were present adjacent to the watercourse on both sides of the highway. Basking and overwintering sites were observed but nesting habitat within the assessed watercourse area was not observed. Since some habitat features were observed during the initial assessment, a VES was recommended to determine if potential wood turtle habitat occurred further upstream or downstream. The watercourse remained narrow further up and downstream. Suitable overwintering or nesting sites were not observed. The VES could not be conducted on the north side of the highway due to the presence of farm fencing and grazing cattle.

**Figure 3.31 WC-71 with marsh and forested swamp riparian areas.**

### 3.8.3.11 WC-72-(Pushies Brook)

WC-72 is a small permanent watercourse with low flow at the time of assessment in 2016, as well as clear waters and mixed substrate. Riparian habitat is primarily comprised of upland mixed forest (Figure 3.32), although other habitat types are present within 50 m of the watercourse. Various wood turtle food sources were observed, although basking, nesting, and overwintering sites were not present along the assessed portion of this watercourse. Although many wood turtle habitat features were not observed, the watercourse appeared to be suitable habitat and was recommended for a VES to further assess potential habitat further up- and downstream. During the VES in 2017, WC-72 passed through a swamp-fen complex with a thick shrub layer that inhibited the visual survey (Figure 3.33). During the VES, it was determined that WC-72 was not suitable for overwintering as there was low flow, no deep pools, and shallow water which would likely freeze to the bottom. WC-72 was determined to be not suitable wood turtle habitat.

**Figure 3.32 WC-72 and upland mixed-wood habitat.**

**Figure 3.33 A swamp-fen complex surrounding WC-72.**

## 3.9 Regulatory Considerations for Aquatic Environment

Under current legislation, linear project activities that could interact with the aquatic environment typically adhere to the following acts:

- Federal *Fisheries Act*. R.S.C., 1985, c.F-14;
- Federal *Navigation Protection Act*. R.S.C., 1985, c.N-22;
- Federal *Species at Risk Act*. S.C. 2002, c.29;
- Provincial *Endangered Species Act*. 1998, c.11, s.1; and
- Provincial *Environment Act*. 1994-1995, c.1, s.1;
  - Activities Designation Regulations (Section 66 of *Environment Act*)

Should the proposed twinning of Highway 104 proceed, the Project may be subject to environmental permits and approvals pursuant to federal and provincial legislation. These regulator considerations are for aquatic habitat, additional federal and provincial legislation may need to be considered for other field programs

# CHAPTER 4 DISCUSSION

## 4.1 Summary of Findings

### *4.1.1 Fish Habitat Assessment*

CBCL assessed fish habitat quality for a total of 170 watercourses within the Study Area during the 2016 and 2018 aquatics program conducted on behalf of NSTIR. The majority of assessed watercourses were classified as ‘intermittent with ephemeral characteristics’ (81), followed by ‘intermittent’ (32) and ‘ephemeral’ (25). The remainder were classified as ‘small permanent’ (14), ‘small permanent with intermittent characteristics’ (9) and ‘large permanent’ (9). The majority of the assessed permanent watercourses provided ‘moderate’ to ‘good’ overall habitat functions for salmonids. Many of these watercourses provided high percentages of suitable substrate for spawning (i.e., small and large gravel), moderate to abundant quantities of instream cover, deep pools, good flow, and optimal water quality results. Whereas, intermittent and ephemeral streams generally contained habitat characteristics not suitable for salmonids, as they were frequently dominated by fine substrates, lacked deep pools for overwintering, and were often dry or had very low flow (see ‘Fish Habitat Fact Sheets’ in Appendix F).

### *4.1.2 Fish Sampling*

A total of eight (8) fish species were captured and confirmed within the Study Area during the electrofishing program. Four (4) were CRA fish species, and four (4) were CRA support species. Two (2) SOCC were confirmed within the Study Area, including Atlantic salmon and brook trout. Atlantic salmon were captured in three (3) watercourses, while brook trout were caught in thirty-three (33) watercourses.

### *4.1.3 Fish Bearing Watercourses*

In total, 128 of 170 watercourses were identified as having potential for fish at some point during the year within the Study Area. Fifty-two (52) of the 170 watercourses were confirmed to be fish bearing within the Study Area according to criteria outlined in Section 3.4. The remaining 76 watercourses have the potential to contain fish at some point during the year. Forty-two (42) watercourses had no potential for fish within the Study Area.

Although 170 watercourses were identified within the Study Area, only 127 of these watercourses were identified in the Project Area. A total of 100 watercourses identified within the Project area have the potential for fish at some point during the year; 27 watercourses have no potential for fish presence.

### *4.1.4 CRA Fisheries and Species at Risk Assessment*

Through a desktop review and consultation with DFO, 13 CRA species and 7 potential support species were identified as probable residents within the Study Area (see Table 3.2). Five of these species are considered species of conservation concern by ACCDC; 3 of these 5 have been identified as species at risk by COSEWIC and are indicated below.

- Brook trout (S-Rank: S3);
- Atlantic salmon (S-Rank: S1; COSEWIC: Special Concern);
- American eel (S-Rank: S2; COSEWIC: Threatened);
- Striped bass (S-Rank: S2S3N; COSEWIC: Special Concern); and
- Gaspereau / Alewife (S-Rank: S3).

### *4.1.5 Wood Turtle Habitat Assessment and Visual Encounter Surveys*

A total of 20 watercourses were assessed for potential wood turtle habitat in August 2016 (see Table 2.3). Of the watercourses surveyed, 6 were permanent watercourses (2 large permanent, 3 small permanent, and 1 small permanent with intermittent characteristics) and 14 were intermittent watercourses (13 intermittent and 1 intermittent with ephemeral characteristics). Each watercourse assessed had low to medium overstory and understory densities. Surveyed watercourses were also within 100 m to 'high risk' habitats. High risk habitats are areas occupied by turtles where they are at risk of being injured or killed by machinery (e.g., due to roads, ATV trails, and agricultural fields). Surveyors observed potential nesting areas along three of the surveyed watercourses. Potential overwintering sites were observed along 17 of the watercourses surveyed.

A total of 14 watercourses were recommended for VES as they potentially provide wood turtle habitat (Table 3.7). Of the 14 watercourses selected, full VES were conducted in October 2016 on 8 watercourses, and a partial VES was conducted on 1 watercourse (WC-70) but aborted after 17 minutes due to unsuitable habitat. VES were not initiated in 2016 on the remaining 6 out of 14 recommended watercourses, as these were deemed unsuitable habitat for wood turtles by CBCL Biologists upon arrival on site.

In 2017, based on recommendation from the previous year's studies and incorporating habitat quality observations collected during fish studies in the watercourses, full VES were conducted on 11 watercourses within the Study Area. No wood turtles were observed along any of the watercourses in 2016 or 2017, however potential nesting and overwintering sites were identified along most watercourses.

## 4.2 Assessment Limitations

### *4.2.1 Fish Habitat Assessments*

One main factor that can affect the assessment of instream habitat is local weather and the time of year. The water level in watercourses assessed in the spring tend to be higher due to spring run-off and higher precipitation. Watercourses assessed in the summer are often subject to drought conditions or lower water levels due to a lack of precipitation; however, flash flooding can occur during summer storm events. This can make ephemeral and intermittent watercourses difficult to identify. Watercourses assessed in the fall often have mid to high water levels due to higher precipitation amounts. In general, the amount of precipitation that a given area receives in the months, weeks and days prior to a watercourse's habitat assessment will affect the outcome of that assessment.

The Study Area was surveyed for watercourses in 2016 and 2018. The Canadian Drought Monitor reports annual precipitation assessments for the month of September. According to these reports, the western end of the Study Area was classified as 'abnormally dry', while the eastern end of the Study Area was classified as experiencing a 'moderate drought' in September 2016 (Government of Canada, 2018). While surveys conducted in 2016 made additional efforts to note morphological characteristics under 2016 conditions and to predict characteristics during 'normal' conditions, it is plausible that certain stream features were under- or over-represented, which could impact the overall habitat quality analysis. For example, many small permanent watercourses were considerably shallow or dry due to drought and thus lacked 'good' habitat such as suitable flow, riffles and deep pools. Water quality parameters, particularly temperature and dissolved oxygen, are likely not representative in some cases, primarily with intermittent or ephemeral streams. In some instances, water quality parameters could not be recorded during 2016 habitat assessments because the probe could not be fully submerged. As well, deep pools found were often stagnant with little to no flow. While these climatic conditions presented assessment limitations during the 2016 survey year, watercourses were revisited during the 2018 field programs; habitat assessments were updated and water quality parameters were collected again, thereby minimizing any assessment limitations associated with local climate.

### *4.2.2 Wood Turtle Surveys*

As stated by Jones and Willey (2015), surveys for wood turtles have higher detection rates in the spring. Since the initial VES were conducted in the fall of 2016 after the spring survey period, it is possible that wood turtles were present within the Study Area, but were missed due to low detections rates. To address this limitation, additional VES were completed in the spring of 2017 (CBCL, 2017).

Due to drought conditions reported in September 2016 (Government of Canada, 2018) and the markedly dry summer, wood turtle habitat assessments may not always accurately represent habitat quality under normal conditions. For example, the amount of nesting habitat observed could be an overestimate as more sidebars and islands were exposed with lower water levels. These exposed areas may be submerged during normal weather conditions. Additionally, overwintering sites, particularly deep pools, may not have been noted due to low water conditions. Under normal water levels, deep pools and overwintering sites may be more abundant than what was recorded during the wood turtle habitat assessments.

As discussed in Section 2.4, the overall detection rate of wood turtles in Nova Scotia is low (Pulsifer, M. pers. comm., 2017). Although multiple survey rounds were conducted as a means to account for these low detection rates, it is possible that wood turtles present within the survey areas were not detected.

While VES were conducted within the optimal window (Pulsifer, M. pers. comm., 2017), 'green-up' of vegetation during the second week of VES may have limited wood turtle detection to some extent.

As discussed in Section 3.1, wood turtles emerge from watercourses when the air temperature exceeds water temperature and prefer to bask in open areas accessible to direct sunlight. It is possible certain conditions may have limited the number of wood turtles basking, and subsequently being detected, when air temperature was lower than water temperature, and when cloud cover was either partly cloudy or overcast

## 4.3 Closure

This report has been prepared for the sole benefit of Nova Scotia Transportation and Infrastructure Renewal. The report may not be relied upon by any other person or entity without the express written consent of CBCL Limited and Nova Scotia Department of Transportation and Infrastructure Renewal.

Any use which a third party makes of this report and any reliance on decisions made based on it, are the responsibility of such third parties. CBCL Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this report.

The conclusions presented represent the best judgement of the assessors based on the observed site conditions. Due to the nature of the investigation, the assessors cannot warrant against undiscovered environmental conditions or liabilities.

Should additional information become available, CBCL Limited requests that this information be brought to our attention so that we may re-assess the conclusions presented herein. Any changes to the Corridor alignment may result in a requirement to replicate the field program to capture any new information.

Respectfully submitted,
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