Environmental Impact Assessment Registration: Mactaquac Life Achievement Project

Final Report

July 7, 2023

Prepared for:

New Brunswick Power Corporation
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File: 121415886

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1.0 INTRODUCTION

This document is an environmental impact assessment (EIA) registration document for the Mactaquac Life Achievement Project (MLAP, or the Project) being proposed by the New Brunswick Power Corporation (NB Power). The Project will include a variety of rehabilitation activities aimed at enabling the existing Mactaquac Generating Station (MQGS) to achieve its original design service life. These activities will include, but not be limited to, concrete repairs and replacement, waterproofing, sealing, replacement/repair of structures, replacement/repair of generation equipment and ancillary electrical and mechanical components, temporary fish passage, and enhancements to long-term fish passage.

This document is submitted to the New Brunswick Department of Environment and Local Government (NBDELG) to initiate a Determination Review under Section 5(2) of the New Brunswick *Environmental Impact Assessment Regulation 87-83* of the *Clean Environment Act*.

1.1 OVERVIEW OF THE PROJECT

The MQGS is located on the St. John River (Wolastoq), approximately 20 km west of Fredericton, New Brunswick (Figure 1.1). It was commissioned in 1968 and is NB Power's largest hydroelectric generation facility. The MQGS includes a rock-fill main dam, a concrete diversion sluiceway, a concrete spillway, an intake structure, a powerhouse with six turbine-generator units, fish collection facility, and related terminals and transmission infrastructure. There is an administration building and land-based ancillary facilities on-site.

The MQGS has an approximate generation capacity of 670 megawatts (MW) of electricity from its six turbine-generator units. The facility is used for both peaking and load-following generation as well as providing ancillary services necessary to New Brunswick's electricity system. In the event of a system-wide black-out, MQGS is the first unit required to restart the grid. MQGS also serves as the operations centre for almost all of NB Power's 889 MW hydroelectric system. Currently, MQGS provides 75% of NB Power's hydroelectric generating capacity, 18% of New Brunswick's total generating capacity, and 20% to 30% of the Province's legislated renewable energy requirements.

The concrete structures at MQGS are affected by an alkali aggregate reaction (AAR). AAR is a reaction between alkali materials in cement and silica in the aggregate that causes the concrete to expand. This reaction has resulted in substantial cracking, leading to accelerated concrete deterioration and seepage of headpond waters through the structures. AAR affects the performance of the powerhouse, water retaining structures, gates, and generating units.

Following a years-long in-depth research and evaluation process that included input from Indigenous groups, the public, engineers, and scientists, the approach outlined in this document was determined. In-situ rehabilitation of the MQGS concrete structures and equipment will allow the facility to achieve its original planned service life of 100 years.

Stantec

- Project Development Area
- Collector Road
- Other Road
- Resource Road / Trail
- Transmission Line
- Watercourse (DNR)
- Waterbody (DNR)
- Wetland (DELG)
- Provincial Park
- Kingsclear First Nation
- Local Service District

0 600 1,200 metres
(At original document size of 8.5x11)
1:50,000

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan,

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-11-23

Client/Project 121415886_001
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
1.1

Title
Project Location

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1.2 PROPONENT INFORMATION

Name of Proponent:	New Brunswick Power Corporation (NB Power)
President & Chief Executive Officer:	Lori Clark President and CEO (Acting)
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Proponent Website:	www.nbpower.com

1.3 PURPOSE/RATIONALE/NEED FOR THE PROJECT

The objective of the MLAP is to restore the generating capacity of the MQGS by extending its operational life to the original intended 100-year service life (*i.e.*, to the year 2068), or as close as possible to it. This will provide a stable source of renewable energy in New Brunswick well into the future.

Renewable energy sources are increasingly valuable as society works to meet the energy demands of North America while reducing greenhouse gas emissions. Hydroelectric power is a renewable energy source that has been used extensively to generate electrical power throughout much of Canada and the United States. With renewed interest by governments about climate change due to greenhouse gas emissions, and with regulatory mechanisms (*e.g.*, carbon tax, output-based pricing systems) being developed to combat climate change, electric utilities throughout North America are increasingly interested in non-emitting, renewable energy sources to meet societal demands for electricity while also aligning with Canada's climate change commitments.

1.4 REGULATORY FRAMEWORK

This section provides an overview of the major regulatory processes that could be applicable to the Project, including federal and provincial environmental assessment requirements and the roles of regulatory authorities. The following list of regulatory processes is not considered to be exhaustive, and provincial and/or federal authorities could require adherence to other regulations.

1.4.1 Provincial

1.4.1.1 New Brunswick *Environmental Impact Assessment Regulation*

The New Brunswick *Environmental Impact Assessment Regulation 87-83* under the *Clean Environment Act* (EIA Regulation) governs the EIA process in the province. The EIA Regulation requires that all undertakings listed in "Schedule A" of the Regulation (including their proposed construction, operation, modification, extension, abandonment, demolition, or rehabilitation) undergo at minimum a registration and a "Determination Review" led by the NBDELG to review the Project's information and potential environmental effects. That same information was also provided to the New Brunswick Department of Aboriginal Affairs to determine if, and to what extent, formal consultation is required with New Brunswick's Indigenous communities

In April 2022, NB Power provided information to NBDELG regarding MLAP to confirm that an EIA Registration is required. NBDELG provided a letter dated May 6, 2022, confirming that MLAP requires an EIA Registration as it is considered to be an undertaking under the EIA Regulation, according to, at minimum, items b, c, s, and u of Schedule A of the regulation, as follows:

> *(b) all electric power generating facilities with a production rating of three megawatts or more*
>
> *(c) all water reservoirs with a storage capacity of more than ten million cubic metres*
>
> *(s) all waterworks with a capacity greater than fifty cubic metres of water daily*
>
> *(u) all enterprises, activities, projects, structures, works or programs affecting any unique, rare or endangered feature of the environment*

Following registration, NBDELG will form a Technical Review Committee (TRC) to undertake a Determination Review of the submitted EIA documentation. During or following this review, the TRC may require additional information and pose questions for NB Power to address. As described above, at the conclusion of the Determination Review, the TRC will make a recommendation to the Minister of Environment and Local Government who will decide if the Project can proceed, with or without conditions, or if a more formal EIA ("comprehensive review") is required.

1.4.1.2 New Brunswick *Species at Risk Act*

The New Brunswick *Species at Risk Act* (NB *SARA*) is intended to protect species from extirpation and extinction. Species that are included in the *Prohibitions Regulation* of NB *SARA* currently have some regulatory protection. Schedule A of NB *SARA* lists species in New Brunswick that are classified as being Extirpated, Endangered, Threatened, or of Special Concern. The NB *SARA*, by way of Section 28(2), prohibits the killing, harming, harassing, or taking of any species listed in Schedule A.

1.4.1.3 New Brunswick *Watercourse and Wetland Alteration Regulation–Clean Water Act*

The New Brunswick *Watercourse and Wetland Alteration Regulation–Clean Water Act* requires a watercourse and wetland alteration (WAWA) permit to be issued for any activity carried out within 30 m of a watercourse or wetland.

1.4.1.4 New Brunswick *Fish and Wildlife Act*

The New Brunswick *Fish and Wildlife Act* protects all fish and wildlife species from angling, hunting, trapping, and other forms of intentional take except under the authority of permits or licenses.

1.4.2 Federal

1.4.2.1 *Impact Assessment Act*

The *Impact Assessment Act* (IAA) defines the requirements for federal impact assessments and the prevention of significant adverse environmental effects in Canada. The IAA applies mainly to designated projects listed in the *Physical Activities Regulations* (the Project List). Sections 42 and 43 of the Project List include:

> *42. The construction, operation, decommissioning and abandonment of…*
>
> > *a) a new hydroelectric generating facility with a production capacity of 200 MW or more*
>
> *43. The expansion of…*
>
> > *a) an existing hydroelectric generating facility if the expansion would result in an increase in production capacity of 50% or more and a total production capacity of 200 MW or more*

The Project is not a designated project as defined by the Project List under the IAA, as it is neither a new hydroelectric generating facility, nor an expansion of 50% or more.

The federal Minister of Environment and Climate Change Canada may, at their discretion, designate a Project that is not on the Project List. The Minister may exercise this authority if they are of the opinion that a project may cause adverse effects within federal jurisdiction, or if public concerns related to those effects warrant designation.

1.4.2.2 *Fisheries Act*

The *Fisheries Act* defines the requirements for protecting fish and fish habitat in Canada. Specifically, the *Fisheries Act* specifies that any activity that could result in the death of fish (by means other than fishing, Section 34.4) or the harmful alteration, disruption, or destruction (HADD) of fish habitat requires an authorization to be issued, with appropriate offsetting for residual environmental effects of the activity.

Additionally, Section 36(3) of the *Fisheries Act* states that it is illegal to release deleterious substances into a fish-bearing watercourse or waterbody. A deleterious substance is considered any substance that can degrade water quality such that it becomes harmful to fish or fish habitat.

1.4.2.3 *Species at Risk Act*

The federal *Species at Risk Act* (*SARA*) lists species in Canada that are classified as being extirpated, endangered, threatened, or of special concern. The purpose of *SARA* is to protect species at risk and the habitat of these species.

Schedule 1 of *SARA* lists over 300 wild species of plants and animals that are provided special measures to protect them and assist in their recovery. These measures include, but are not limited to, prohibitions against:

- The killing, harming, or harassment of these species
- The damage or destruction of their residences
- The destruction of any part of their critical habitat

1.4.2.4 *Migratory Birds Convention Act*

The federal *Migratory Birds Convention Act* (*MBCA*), by way of the *Migratory Birds Regulations* and *Migratory Birds Sanctuary Regulations*, contains requirements for the protection and conservation of migratory bird populations, individuals, and their nests within all lands in Canada. An estimated 450 native species of migratory birds are protected under the *MBCA*.

1.5 PROPERTY OWNERSHIP

The MQGS is located on Parcel Identification Number (PID) 75258699. The Project will be carried out on land owned by NB Power.

2.0 PROJECT DESCRIPTION

This chapter provides a description of the Mactaquac Life Achievement Program (the "MLAP" or the "Project") as it is currently conceived. It provides an overview of the existing facilities at the Mactaquac Generating Station (MQGS), a brief discussion of Project alternatives and siting considerations, a Project schedule, and a description of how the Project will be constructed, operated and maintained, and decommissioned at the end of its service life.

The MQGS is located on the St. John River (Wolastoq), approximately 20 km west of Fredericton, New Brunswick (Figure 2.1). It was commissioned in 1968 and is the largest hydroelectric generation facility operated by New Brunswick Power Corporation (NB Power). The MQGS was designed with an expected service life of approximately 100 years, with an estimated end of service life date of 2068.

The MQGS has a net generation capacity of approximately 670 megawatts (MW) of electricity from its six turbine-generator units. The facility is used for both peaking and load-following generation as well as providing ancillary services necessary to New Brunswick's electricity grid. In the event of a system-wide black-out, MQGS is the first unit required to restart the grid. MQGS also serves as the operations centre for almost all of NB Power's 889 MW hydroelectric system. Currently, the MQGS provides approximately 75% of NB Power's hydroelectric generating capacity, 18% of New Brunswick's total generating capacity, and between 20% and 30% of the Province's legislated renewable energy requirements.

The MQGS includes a rock-fill main dam, a concrete diversion sluiceway, a concrete spillway, an intake structure, a powerhouse with six turbine-generator units, and related terminals and transmission infrastructure (Figures 2.2 and 2.3). There is an administration building and land-based ancillary facilities on-site.

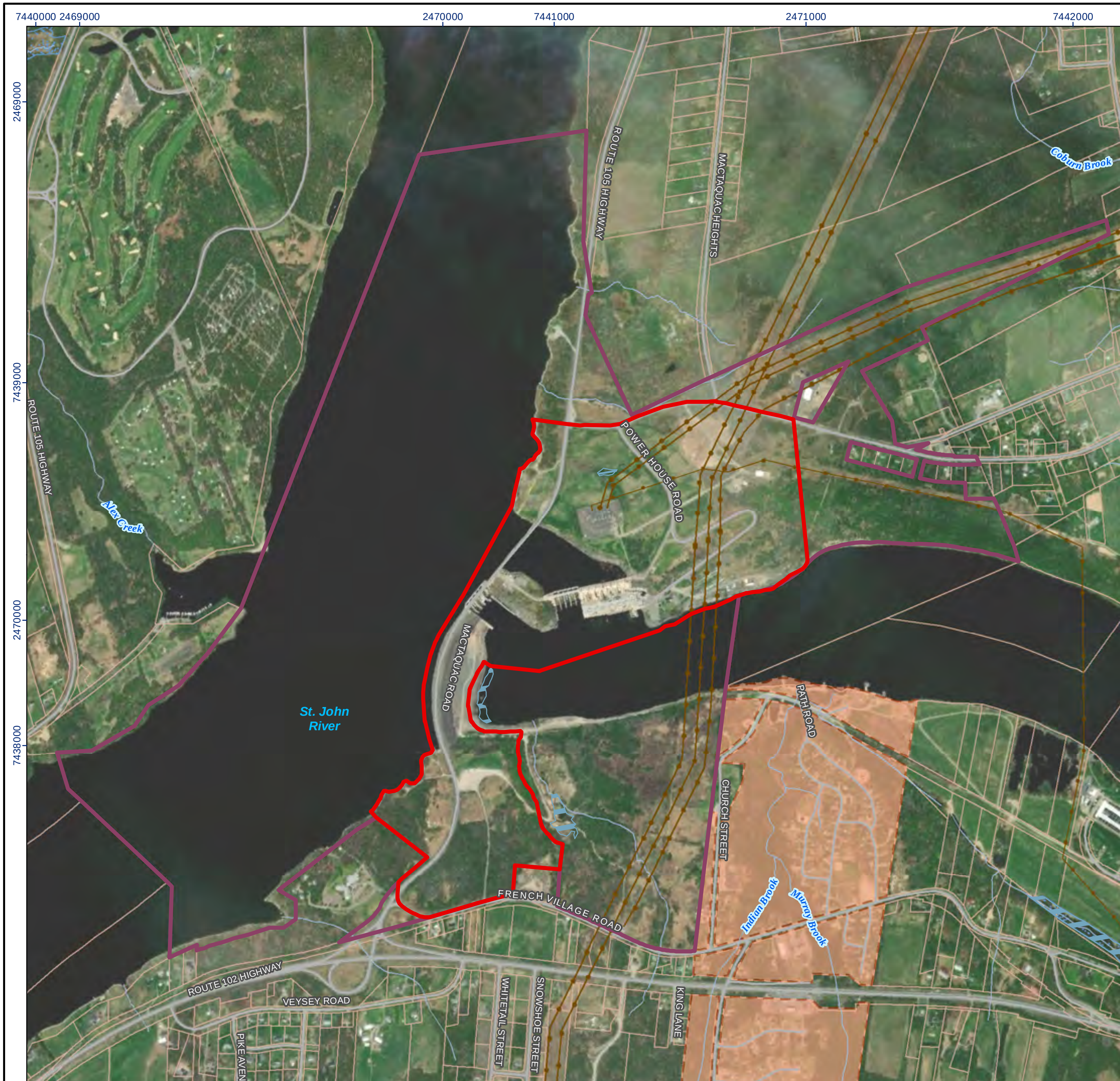
In the early 1970s, NB Power identified an issue with the main concrete structures at the MQGS, in particular with respect to its chemical concrete composition and physical behavior. It was determined at that time and through several decades of study and monitoring that the concrete structures at the MQGS are affected by an alkali aggregate reaction (AAR). AAR is a reaction between alkali materials in cement and silica in the aggregate that causes the concrete to expand. This reaction has resulted in significant cracking, leading to accelerated concrete deterioration and seepage of headpond waters through the structures. AAR affects the performance of the powerhouse, water retaining structures, gates, and generating units.

After further study of potential options for MQGS including preliminary engineering design, comparative environmental review, and social impact comparative review, and a facility condition assessment and with the benefit of experience from other jurisdictions and a more thorough understanding of the condition of the facility, NB Power has determined that in-situ rehabilitation of the concrete structures and equipment could be undertaken to enable the MQGS to achieve its original planned service life of 100 years, referred to as the MLAP.

NB Power conducted a condition assessment of the MQGS to identify areas where repairs, rehabilitation, or replacement of components and structures were required. This condition assessment informed the scope development of the MLAP. The MLAP will consist of a variety of rehabilitation activities aimed at enabling the MQGS to achieve its original design service life, including:

- Main dam: surface repairs to the slopes and roadways
- Main spillway and diversion sluiceway (*i.e.*, spill structures): waterproofing, extensive concrete repairs, replacement of bridges, hoist tower repairs, spill gate and hoist replacement, and upgrades to electrical systems
- Water intake structure: waterproofing, concrete repairs, gate and gantry crane replacement, upgrades to electrical systems, and replacement of various building components
- Powerhouse: waterproofing and sealing, realignment and strengthening of steel superstructure, concrete repairs, dewatering the draft tube, replacement of tailrace gantry crane, rehabilitation of the generating equipment, replacement of mechanical and electrical systems, upgrades to various building components, and draft tube stoplog gate/guide replacement
- Fish passage enhancements: temporary upstream fish passage during construction using the existing trap-and-truck facility and a temporary floating guidance boom, and long term upstream and downstream fish passage improvements including upgrades to the existing trap-and-truck facility, and installation of additional infrastructure to improve downstream fish passage

These features are described in greater detail in Section 2.1. Construction activities associated with the MLAP activities are described in greater detail in Section 2.4, organized based on the location and nature of the work (*e.g.*, in-water work, work in the dry, transportation related activities) to align with the potential environmental effects that will be evaluated in the environmental effects assessment presented in this EIA registration document.



Stantec

- Project Development Area
- PID 75258699
- Road
- Transmission Line
- Watercourse (DNR)
- Wetland (DELG)
- Wetland (Stantec)
- Other Property Parcel
- Kingsclear First Nation

0 250 500
metres
(At original document size of 8.5x11)
1:20,000

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan,

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-11-23

Client/Project 121415886_002a
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
2.1

Title
Project Development Area

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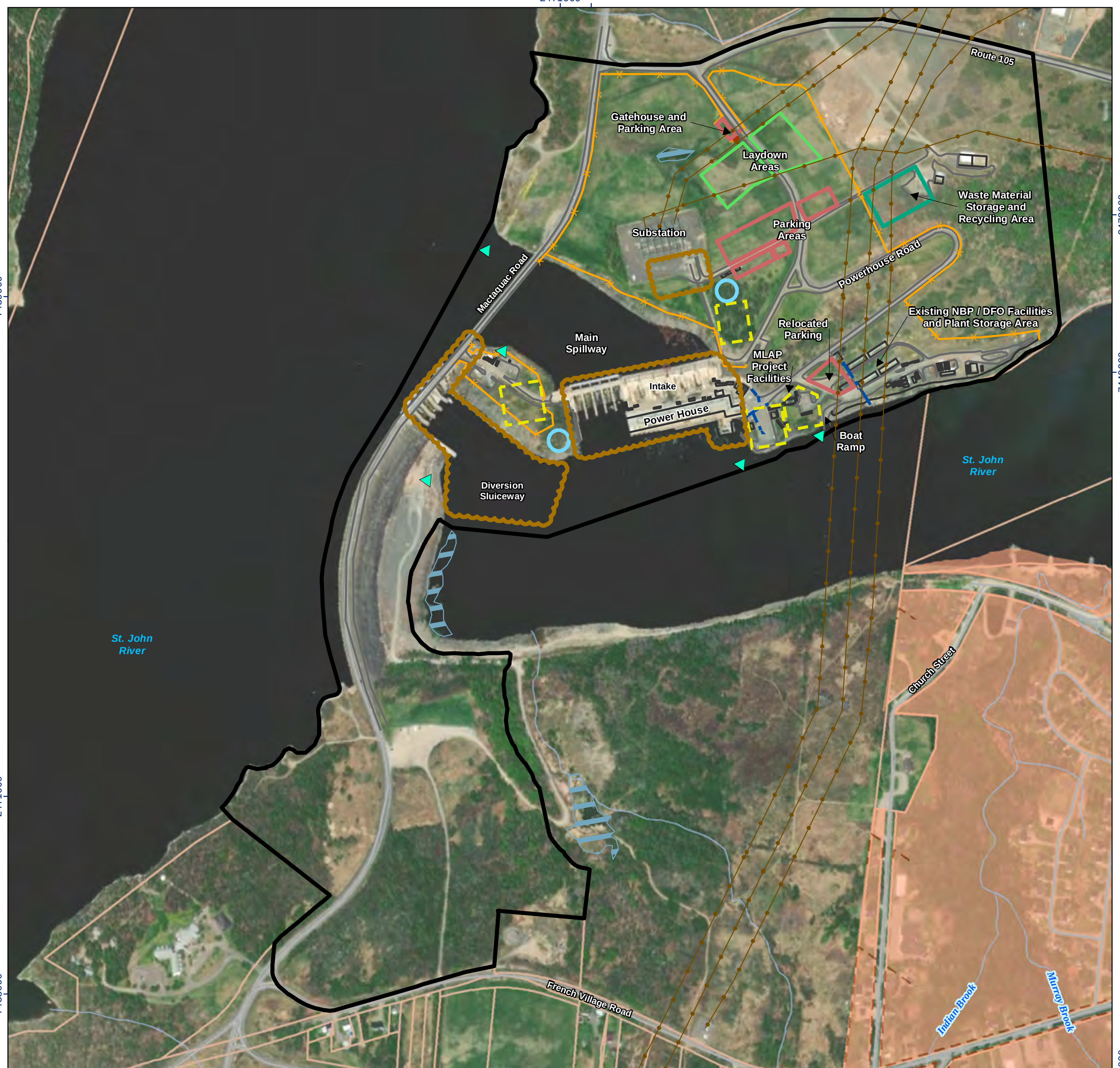

Stantec

Site Features

- Potential Water Access Point
- Construction Area
- Waste Material Storage and Recycling
- Laydown Area
- Temporary Office
- Gatehouse
- Parking
- Potable Water Well
- Existing Building
- Fence
- Road Edge
- Storm Drain
- Project Development Area
- Road
- Transmission Line
- Watercourse (DNR)
- Wetland (Stantec)
- Property Parcel
- Kingsclear First Nation

0 130 260 metres

(At original document size of 8.5x11)
1:10,500

Notes

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Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-11-23

Client/Project 121415886_002
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
2.2

Title
Mactaquac Generating Station Components

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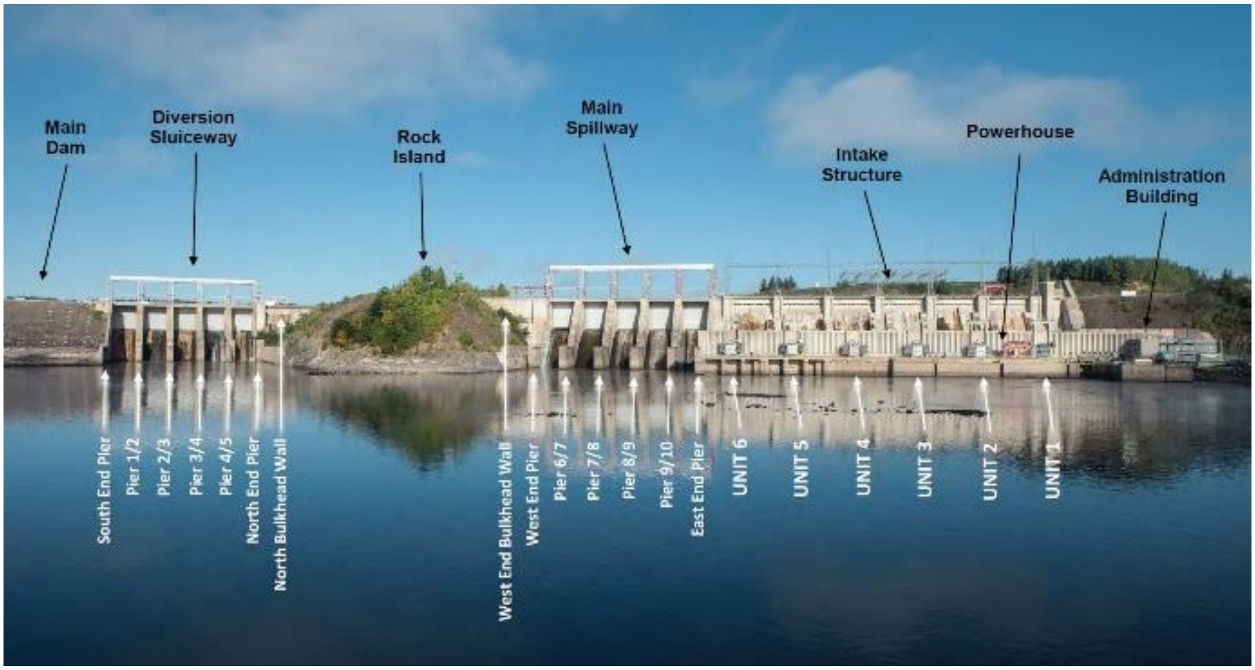


Figure 2.3 Mactaquac Generating Station - Downstream Side

2.1 OVERVIEW OF THE EXISTING MACTAQUAC GENERATING STATION

The MQGS currently consists of the following major components (Figures 2.2 and 2.3):

- A 518 m long earthen dam, known as the main dam, constructed of rock fill and sealed by clay with a crest elevation of 42.37 m above mean sea level (m amsl).
- An 83 m long concrete spillway, known as the main spillway, that contains water to a maximum level of 40.5 m amsl. The main spillway consists of five spill bays and is equipped with mechanically driven metal gates.
- A second spillway, known as the diversion sluiceway, that is of very similar construction to the main spillway and used only during periods of high flow.
- An intake structure with six hydraulic passages (penstocks; one per turbine), equipped with mechanical gates.
- A powerhouse that houses six Kaplan-style hydroelectric turbine-generator units and associated equipment.
- An electrical switchyard and associated transmission infrastructure.
- A fish collection facility operated by Fisheries and Oceans Canada (DFO).
- Associated equipment and instrumentation.

These components are described in greater detail in Sections 2.1.1 to 2.1.4. There is an administration building and land-based ancillary facilities on-site. Mactaquac Road also provides a crossing of the St. John River between Routes 102 and 105 of the provincial highway system. The approach channel bridge is owned and operated by the New Brunswick Department of Transportation and Infrastructure (NBDTI) and is not included in the scope of this EIA Registration.

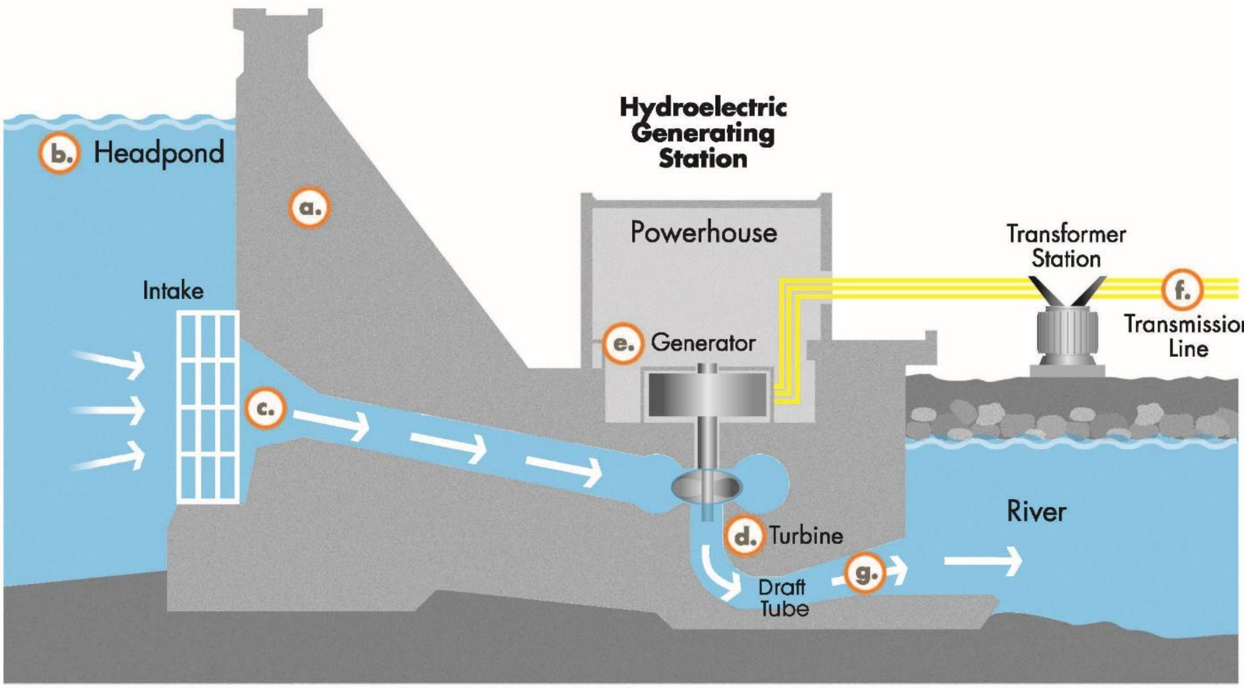
Construction of the MQGS created a 97 km long reservoir (the “headpond”) on the St. John River that extends from the MQGS to approximately 15 km upstream of the town of Woodstock. During high flow periods, the MQGS provides a stable base power load to the electrical system. During low flow periods (*e.g.*, the summer and winter), the MQGS is used to provide power during peak loading periods. The MQGS is operated much like a run-of-the-river dam during periods of high flow (*e.g.*, spring and fall), meaning while there may be natural variations in water levels, water is not generally held back or stored for long periods of time, and flows into the headpond and downstream in the St. John River are equal to the flows through the dam. There is some daily and seasonal storage of water which allows NB Power to fluctuate power generation based on available water and variations in energy demand. NB Power provides a minimum flow downstream during low flow periods, as designated by DFO.

Under normal operating conditions, water levels are maintained between a minimum drawdown level of 39 m amsl (128 ft) and a maximum operating level of 40.5 m amsl (133 ft), which allows for approximately 1.5 m (5 ft) of water level fluctuation. The water level of the St. John River ranges between 3.0 and 6.6 m (10 and 22 ft) amsl immediately downstream of the MQGS.

A schematic of how a hydroelectric generating station generates electricity is provided in Figure 2.4.

How does a hydroelectric generating station make electricity?

Generating hydroelectric power involves using water to turn a propeller-like piece called a turbine, which then turns a metal shaft in a generator to produce electricity.



- **a.** A dam is built on a large river that has a large drop in elevation. That drop in elevation is called "head". The greater the head and the greater the flow of water, the more potential to generate electricity.
- **b.** The dam stores lots of water behind it in a reservoir called a headpond.
- **c.** Near the bottom of the dam wall, there is the water intake. Gravity causes water to fall through the intake into the dam.
- **d.** At the end of the intake there is a large propeller-like device called a turbine, which is turned by the moving water.
- **e.** The shaft from the turbine goes up into the generator (essentially a large motor), which produces the electricity.
- **f.** From the generator, the electricity flows through transmission lines that carry electricity to your home.
- **g.** The water continues past the turbine through the draft tube into the river, past the dam.

Figure 2.4 Hydroelectric Generating Station Schematic

2.1.1 Main Dam

The main dam originates from the southern shore of the St. John River and extends approximately 518 m north across the St. John River. Mactaquac Road crosses the St. John River and connects Route 102 (south side) and Route 105 (north side). The main dam consists of rock fill sealed by clay and is not affected by the AAR; however, it abuts the main diversion sluiceway, and may be affected by AAR-related expansion of the south pier of the sluiceway.

The main dam will require surface repairs to the slopes and roadways, consistent with ongoing maintenance, and instrumentation upgrades.

2.1.2 Water Intake Structure

The water intake structure draws water from the headpond through the MQGS turbines to generate electricity. There are two water intakes per unit, and each water intake is covered by two “trash racks” which prevent large objects such as woody debris from entering and potentially damaging the turbines. Intake head water elevation is maintained at 40.5 m amsl (133 ft) upstream of the intake

Each unit has two rectangular concrete passages covered by trash racks which merge into one circular penstock (*i.e.*, an enclosed pipe on the upstream side of a turbine). These penstocks are 8.8 m (29 ft) in diameter and 54.2 m (178 ft) in length. The penstocks have been cut through their concrete and have had flexible in-line penstock couplings installed between 1996 and 2001 to manage deformation caused by AAR. Each penstock can be isolated from flow using a set of two main gates, or by bulkhead gates if the main gates require maintenance. The intake’s crest or sill elevation, where the bottom of the intake gates rest and seal against the headwater when the gates are inserted in the closed position, is at 18.3 m amsl (60 ft).

The intake structure’s top deck carries an access roadway which passes over the intake, across the main spillway and to Rock Island, which connects to Mactaquac Road.

Work at the intake structure will include waterproofing, concrete repairs, gate and gantry crane replacement, upgrades to electrical systems, and replacement of various components.

2.1.3 Powerhouse

The powerhouse is a concrete structure with a steel superstructure, which houses the MQGS generation equipment (*e.g.*, turbine, generators, ancillary systems) and control systems, as well as individual draft tubes (*i.e.*, water passage on the downstream side of the turbine) for each turbine. It also contains the plant’s key administrative offices, primary unit control room, plant equipment lay down and service bay, and fish collection system, as well as two twin cranes with individual capacities of 77,110 kg and a combined capacity of 145,182 kg.

The powerhouse is connected to the water intake structure. Water flow to the turbines is supplied at the intake structure and is permitted to flow when the unit's individual intake gate (*i.e.*, a vertical roller lift gate) is opened and the turbine's wicket gates (*i.e.*, a series of 24 small gates that are opened together to distribute the water to the turbine runner) are opened. Water flows from the headpond, into the intake structure, and down the penstocks described in Section 2.1.2. The water then enters the turbine's spiral case and flows past the wicket gates and flows over and across the Kaplan turbine blades, thus permitting the turbine shaft to rotate and power the generator. Water exits the turbine, and the flow diffuses outward into the St. John River through the turbine's draft tube (a diffusor) into the tailrace water, where it rejoins the St. John River flow towards the downstream. The powerhouse has a substructure referred to as the tailrace block, which has experienced continued long-term deformation resulting from AAR.

There are six hydroelectric generating units in the powerhouse, powered by Kaplan turbines. The turbines are all now at or nearing the end of their recommended service life.

Work in the powerhouse will include waterproofing and sealing, realignment and strengthening of steel superstructure, concrete repairs, dewatering the draft tube, replacement of tailrace gantry crane, rehabilitation of the generating equipment, replacement of mechanical and electrical systems, upgrades to various building components, and draft tube stoplog gate/guide replacement.

2.1.4 Main Spillway and Diversion Sluiceway

The main spillway and diversion sluiceway are two similar structures used for passing water in spill conditions (*e.g.*, high flows) to lower water levels in the headpond when required. The diversion sluiceway is located immediately north of the main dam, and Mactaquac Road continues on top of the sluiceway before diverging from the MQGS to the NBDTI bridge. The main spillway is separated from the diversion sluiceway by a natural island outcropping, known as Rock Island, which was left in place during the original construction of the MQGS. The north bulkhead wall runs along the upstream side of Rock Island between the diversion sluiceway and the NBDTI bridge.

The main spillway and the diversion sluiceway each consist of five spillway bays separated by six reinforced concrete piers which support an overhead gate hoist structure. The northernmost pier nose of the main spillway is larger than the others for hydraulic purposes and has three smaller log deflector piers located at the base of the spillway. These concrete structures have been affected by AAR issues.

Each spillway bay includes a steel vertical roller lift gate which is lifted and lowered by an overhead electric hoist. Flow through the spillway bays is controlled by opening and closing the gates. Flow through the main spillway bays can also be stopped using stoplogs, which can be installed in slots on the upstream and downstream sides of the spillway bay using a monorail hoist system and isolating the area between the stoplogs from flow. At the diversion sluiceway, stoplogs can be installed in slots on the downstream side.

The gates sealing surface or sill on the upstream side of these structures is located on elevation 24.3 m amsl (80 ft). The downstream water elevation varies in elevation, ranging between 3.8 to 5.9 m amsl (12.5 ft to 19.5 ft). The main spillway bottom elevation goes to -6 m amsl (20 ft) elevation and then up to 1.5m amsl (5 ft). The diversion sluiceway bottom elevation is -4.5 m amsl (15 ft).

The spillway bays and embedded steel roller paths for the vertical roller wheel lift gates are affected by AAR issues, which have affected the alignment of the roller paths and the concrete surfaces of both structures.

Repairs planned for the main spillway and diversion sluiceway structures include waterproofing, extensive concrete repairs, scour protection, replacement of bridges, hoist tower rehabilitation or replacement, spill gate and hoist replacement, stilling basin repairs, and upgrades to electrical systems.

2.1.5 Erosion Protection Works

NB Power has installed erosion protection armour stone along the bank of the St. John River downstream of the MQGS to reduce the potential for erosion to occur in these areas during periods of high flows (*e.g.*, the spring freshet). These erosion protection works will not be altered as part of the MLAP, and NB Power will continue to maintain and repair these works separately from the MLAP.

2.1.6 Bridges

The MQGS has three main bridge structures. These three bridges cross the diversion sluiceway, the main spillway, and the north bulkhead wall.

The main spillway bridge provides access to the spillway equipment and the intake structure and connects by road to Rock Island.

2.2 AAR

AAR can occur in concrete if the composition of the concrete has an aggregate that has a high enough reactivity, and a cement with suitably high alkalinity. When the finished concrete is exposed to adequate moisture over a long enough time, an internal chemical reaction occurs. The end result of this reaction is that the concrete expands in volume.

Detection of the AAR problem was not made during the original construction testing and quality inspections and occurred later once the MQGS was operating. Engineers discovered that the expansion resulting from the AAR was deforming the MQGS's main concrete structures. Deformations occur in the form of growth along paths of least resistance to the expanding concrete, creating translational movement of structures interfaced with the growing concrete masses, and increased pressure at these interfaces, including locations such as the piers of the water intake structure. The result is unplanned loading forces which are hard to model and difficult to determine after the fact. Ultimately, this growth causes concrete stress, pressure, translational movement, cracking, density changes, crumbling, and creates new passages for water leakage in affected structures.

Turbines, generators, spillway gates, pumps, piping, conduits, and penstocks are also all interfaced with AAR-affected concrete. As such, deformations or concrete swelling and transposing its position against embedded steel work of these components substantially affect their very small design tolerances for equipment erections and alignment tolerances. This includes gaps between the rotating components of the turbines and the embedded stationary steel components which are closing and distorting outside of their design tolerances. The generator shaft and bracket alignments are also moving with the AAR and slowly moving out of alignment. Embedded piping and conduits are deforming due to additional stresses that were not accounted for in their original design. There are also structural issues at the powerhouse resulting from the AAR, such as cracking in flooring and other concrete structures, and movement of stairs, work platforms, and walls.

AAR growth has affected the MQGS such that it has caused the concrete of the powerhouse, intake, spillways (main spillway and diversion sluiceway) and interfacing concrete with the turbine and generator to permanently swell and create new, non-design pressures. Severe cracking and weakening of concrete in some locations has resulted. As such, the Project will include provision for AAR corrective work such as removal of interfacing AAR with embedded turbine components, generator components, and spillway mechanical gate seal and interface components.

2.3 PROJECT ALTERNATIVES

In 2013, NB Power initiated an evaluation of several potential options to address the future of the MQGS beyond its projected premature end of service life in 2030. The evaluation included a detailed engineering review, a review of the environmental and social implications of the potential options, and a broad Indigenous, stakeholder, and public engagement program. Several reports were generated to document the results of these analysis and programs, including What Was Said Final Report (National 2016), Final Comparative Environmental Review Report (Stantec 2016), and Final Social Impact Comparative Review (Dillon 2016). The three end-of-life Project Options that were considered by NB Power at that time were:

- Option 1 - Repower: This option would require construction of a new powerhouse, switchyard, fish passage facility and spillway. Existing concrete structures would be partially removed following construction.
- Option 2 - No Power: This option would require replacement of concrete spillways to maintain downstream flow control, and construction of fish passage facility. Existing concrete structures would be partially removed.
- Option 3 - Restore the River: This option would require removal of the powerhouse, main spillway, and diversion sluiceway and associated infrastructure. The earthen dam would be decommissioned and removed.

Options 2 and 3 would have resulted in a reduction in renewable energy produced within New Brunswick (NB Power 2016). As such, this renewable energy would have needed to be replaced through another renewable source. The end-of-life options were chosen for consideration because they were determined to be technically achievable, and they would provide a long-term solution to problems facing the current MQGS.

In addition to the three end-of-life options, the Comparative Environmental Review Report identified that, at the time, NB Power was continuing to explore ways to continue operations within the current footprint beyond 2030 (*i.e.*, due diligence studies). The work done on the MQGS as part of these other possible approaches would not require a material change from current operations. This was considered as the Life Achievement option.

The due diligence studies related to the Life Achievement option included:

- The development of sophisticated finite element models to simulate the AAR expansion and the anticipated effect of AAR on the integrity of the concrete structures over time.
- An evaluation of possible partial refurbishment, whereby the existing components of the powerhouse and other concrete and mechanical components at the MQGS would be demolished in their current footprint and rebuilt with new components.
- An evaluation of possible maintenance, repair, and/or refurbishment activities on existing MQGS components to maintain those units as operational for as long as possible, within the current footprint and with minimal new components.

Results from these studies showed that the Life Achievement option could maintain the MQGS as operational for the remainder of its original intended service life by maintaining or partially refurbishing the existing Station components. Feedback and input from Indigenous communities, stakeholders, and the public was actively sought by NB Power through open houses, social media campaigns, online surveys, and a community liaison committee. This feedback was an important consideration in selecting the Life Achievement option.

NB Power selected this Life Achievement option as the preferred path forward, which ultimately became the MLAP.

2.4 CONSTRUCTION

A project development area (PDA) which encompasses the anticipated area of physical disturbance associated with Project activities during construction is depicted on Figure 2.1.

The main construction activities associated with the Project will include concrete repairs and waterproofing, replacement of infrastructure such as hoists and cranes, and various building components and electrical and mechanical systems, as well as the rehabilitation of the MQGS generating equipment (*e.g.*, turbines).

The primary Project activities are listed in Table 2.1 and categorized by the location within the MQGS where the activity will occur. These activities have been further broken down based on the location of the work in relation to the St. John River (*i.e.*, in-water, isolated, or above the water line) to facilitate the assessment of environmental effects.

The MQGS will continue to operate normally through much of the MLAP construction period. This normal operation will include conducting routine maintenance activities. As these activities would be conducted regardless, they are considered to be outside the scope of the MLAP and are not discussed further in the assessment.

Table 2.1 Project Components and Activities during Construction

Project Component	In-Water Work	Isolated Work in the Dry	Work Above the Water Line	Shut Down of Power Units
Main Dam	None	None	• Surface repairs to the slopes and roadways • Instrumentation upgrades	Not applicable
Main Spillway and Diversion Sluiceway	• Waterproofing, grouting, sealing • Concrete repairs to the upstream and downstream faces of the structures, and stilling basins (if this work cannot be isolated) • Stoplog guide repair	• Waterproofing • Concrete repairs to the downstream and upstream face of the structure and stilling basins (if practicable) • Rehabilitation of rollways and piers • Stilling basin repairs (if feasible)	• Waterproofing, grouting, sealing within the drainage gallery and the north bulkhead wall and south end pier • Concrete repairs including complete encapsulation of the upstream and downstream concrete faces of the north bulkhead wall and concrete repairs to piers and retaining walls • Replacement of roadway deck and cantilever of the north bulkhead wall • Replacement of spilling structure bridges • Hoist tower rehabilitation or replacement • Spill gate and guide rehabilitation or replacement • Upgrades to electrical systems	As may be required for safety

Table 2.1 Project Components and Activities during Construction

Project Component	In-Water Work	Isolated Work in the Dry	Work Above the Water Line	Shut Down of Power Units
Water Intake Structure	• Waterproofing, grouting, sealing • Concrete repairs to the upstream face of the structure • Replacement or rehabilitation of existing trash rack guides	• Waterproofing, grouting, sealing • Concrete repairs in the water passage • Replacement or repair of existing intake gates • Replacement of electrical systems, including high and low voltage equipment, cabling, lighting, and fire detection	• Waterproofing, grouting, and sealing • Core drilling and pressure grouting • Installation of a grout curtain between water passages • Concrete rehabilitation of the top deck and downstream face of the structure • Gate replacement • Gantry crane replacement • Upgrades to electrical systems • Replacement or rehabilitation of various building components, such as mechanical and electrical balance of plant systems, fire suppression, ventilation, and air conditioning (HVAC) system, doors, windows, and stairs	As may be required for safety, typically 1-3 units

Table 2.1 Project Components and Activities during Construction

Project Component	In-Water Work	Isolated Work in the Dry	Work Above the Water Line	Shut Down of Power Units
Powerhouse	• Waterproofing, grouting and sealing • Concrete repairs on the exterior walls of the structure	• Waterproofing and sealing • Concrete repairs • Dewatering the draft tube • Draft tube stoplog gate/guide replacement • Repairs to the steel liner and expansion joint of the penstock, and application of corrosion protection	• Waterproofing, grouting, and sealing of cracks on floors, walls, and sills, and previous saw cuts • Rehabilitation of generator floor • Rehabilitation of powerhouse end wall • Installation of rebar anchors at locations needed to control AAR movement, injection of structural cracks • Realignment and strengthening of steel superstructure • Replacement of tailrace gantry crane • Upgrades and/or replacement of various building components including roofing, windows, doors, staircases, and fire protection systems as necessary	• Removal of concrete surrounding turbines and generators • Rehabilitation of generating equipment • Replacement of unit transformers on the tailrace deck • Replacement of mechanical and electrical systems including high and low voltage equipment, cabling, lighting, and fire detection
Fish Passage	• Installation of floating guidance booms and trap	• None	• Anchoring of fish passage system	• Not applicable
Ancillary Facilities	• Construction of temporary wharves and boat ramps • Scour protection of riverbed in the tailrace	• None	• Development of ancillary facilities including laydown areas, wastewater and sewage treatment plants, potable water wells, parking areas, settling pond, waste material storage and recycling area, temporary offices, on-site roads, and fencing	• Not applicable

Note:

NB Power will continue to conduct various ongoing maintenance activities at the MQGS throughout Project construction. These routine and ongoing maintenance activities are outside the scope of the Project and are not considered further in this assessment.

2.4.1 Construction Methods

2.4.1.1 Concrete Repairs

The method of concrete repairs will depend on the location and extent of damaged concrete. In general, damaged concrete may be removed using a combination of hydrodemolition, milling, scarifying, drum cutter, or mechanical hammer equipment.

Hand tools such as chipping hammers, rivet busters, or jackhammers will be used for small areas and areas with limited access or limited working space.

Hydraulic breakers or drum cutters mounted on long-reach excavators will be used in larger areas, and can be submerged for demolition below the water line up to a depth of approximately 30 m.

Hydrodemolition uses high-pressure water jets for the controlled removal of concrete. Hydrodemolition can be conducted manually using a hand-held lance, or via track mounted equipment, or robotic equipment mounted on a steel frame which is lowered into place using a mobile crane or boom truck. For thick sections of concrete, demolition may be accomplished by cutting concrete blocks using diamond wire saws and removing them piece by piece using lifting equipment. Typically, the concrete surface will be removed beyond the rebar mat to a depth of 173 mm to 400 mm. Broken concrete pieces will be collected from the work area and taken to a designated storage area for eventual disposal.

Once damaged concrete has been removed in a defined area, the remaining surface of the concrete is roughened, and rebar and formwork are installed where necessary using hand tools and lifting equipment (*e.g.*, cranes or boom trucks). Remaining cracks and splits will be grouted using Portland cement or similar material and sealed using epoxy material, flexible elastomeric materials and packing, or polyurethane sealant material. When grouting and sealing is completed and grout and sealant has cured, an outer layer of concrete is poured and allowed to cure. All concrete will be manufactured by approved concrete ready-mix plants bringing concrete to the MQGS site; at this time, an on-site concrete batch plant is not planned as part of the Project. Aggregates used by the concrete ready-mix plants will be sourced from approved off-site borrow sources and will be tested to ensure they will not result in AAR.

The outer layer of concrete will be resurfaced using concrete re-surfacer, which typically consists of a type of polymer-modified flowable mortar. The existing concrete surface will be saturated with water and the re-surfacer will be applied in a thin layer to cover the areas requiring repair. The purpose of the resurfacing is to create a protective barrier over the concrete structure to extend the concrete’s life. Resurfacing will occur over the entire surface of the north bulkhead wall, and over large sections of the other structures where concrete repairs are undertaken.

2.4.1.2 Grouting and Water Proofing

Grouting projects have been conducted historically at the MQGS, and the same methods will continue to be used for the Project, with the potential to migrate to a low alkali grout.

2.4.1.3 Water Management

A large volume of wastewater will be generated through removal (*e.g.*, hydrodemolition) of damaged concrete, drilling and grouting, and concrete cutting. This characteristics of this wastewater will vary by activity but will generally consist of water and concrete fines, excess grout, and/or drilling fluids.

Wastewater generated from these activities will be collected during the activity using a location specific approach determined by the construction contractor, that typically will consist of the use of tarps, sandbags, formwork, or silt curtains. During drilling, return water and drill cuttings will be collected in a sludge recovery box installed over the drill hole.

Wastewater from these activities will be stored in tanks and conveyed to a temporary on-site treatment system for treatment. Holding tanks will also be installed for discharge to a catch basin during overflow conditions (GHD 2021). Separately from the MLAP, NB Power is conducting pilot-scale tests to develop a effluent and sludge treatment and disposal process for water and solids created through demolition of concrete, grouting, and drilling (known as the “AAR Mitigation Project”; GHD 2021). An Environmental Impact Registration for the development of this effluent treatment system has been submitted to NBDELG and a determination review is in progress (GHD 2021). It is anticipated that the effluent treatment system that is implemented as a result of this separate project will also be used for to treat effluent generated by concrete cutting and grouting conducted as part of the MLAP. The treatment technology to be used has not yet been determined however, it is anticipated that the treatment system(s) will first separate suspended fines from the wastewater using filter bags, and/or flocculant as required. If required, the pH of the treated effluent will be adjusted (*e.g.*, CO_2 bubbler system, acid muriatic, or dry ice).

Wastewater will be discharged to the St. John River and will meet the discharge limits established through the approval process for the Grouting Project or discharge criteria specified in the MLAP Approval to Construct. The number, location, capacity, and design of on-site treatment system will be determined during detailed design engineering, pending the results of the Grouting Project.

Solid wastes separated by the treatment system will be transported by a local carrier and disposed of at either the Fredericton or Saint John regional landfill as non-hazardous waste (GHD 2021).

2.4.1.4 Construction Materials

An approximate quantity of construction materials required for major civil works is provided in Table 2.2 below. These quantities will be refined during detailed design engineering.

Table 2.2 Approximate Material Quantities for Major Civil Works

Item	Powerhouse	Intake	Diversion Sluiceway	Main Spillway	Total
Concrete (m^3)	2,200	7,700	3,200	3,900	17,000
Structural Steel (kg)	38,200	-	-	-	38,200
Reinforcing Steel (kg)	39,900	7,300	485,300	489,200	1,021,700
Concrete Removal and Disposal (m^3)	-	7,400	3,200	3,700	14,300

Repair and replacement of infrastructure will include dismantling structures using powered hand tools such as jackhammers and grinders as well as self-propelled equipment. The structures will be broken down into smaller component parts for easier transport and removed using cranes, hoists, and trucks. Demolition waste will be separated into components that can be re-used elsewhere, recycled, or disposed of at an approved facility.

2.4.2 Site Preparation

It is assumed for this EIA registration that the entire area of the PDA will be disturbed as part of site preparation, though it is likely that parts of the PDA will remain undisturbed. Site preparation will include surveying, clearing and vegetation removal of vegetated areas, grubbing, leveling, upgrading, and paving of some portions of the PDA. Temporary ancillary areas will be developed as required. Site preparation will be conducted using self-propelled earth moving machinery including bulldozers, excavators, and large trucks.

As part of site preparation, defined construction zones will be established and fences will be installed to control access. As shown on Figure 2.1, several laydown and parking areas will be prepared on the NB Power property. These areas currently consist of disturbed land (*e.g.*, gravel-covered parking areas) or manicured lawns. Clearing, if and as required, and grubbing will be conducted as required and will be planned for outside the breeding bird season (April 12 to August 27). Laydown areas will be graded and graveled. Settling ponds will be installed as lined pits used to capture site runoff, as well as dedicated settling ponds for use during cofferdam dewatering when required. Separate settling tanks or ponds will be used for effluent produced from concrete removal and grouting. Most ancillary works will be temporary and decommissioned at the end of Project construction. Modifications to the terminal switchyard may also be required to facilitate construction (*e.g.*, installation of additional transformers).

Contractor facilities will be located on the NB Power property, and will include temporary offices, lunchrooms, washroom facilities, and contractor work areas. Additional temporary workspace may also be developed on the south side of the St. John River in an existing gravel parking area adjacent to the main dam, and on the west side of Mactaquac Road, however the specific use of these areas has not been determined. The areas where these facilities are likely to be located are shown on Figure 2.2.

Dedicated waste materials storage and recycling areas will be located on the NB Power property, as shown on Figure 2.1. Metals will be temporarily stored for reuse or for transport to an off-site recycling facility. This area will also be used for storage and handling of clean concrete from demolition for reuse on site, as well as permanent disposal of clean, inert materials with no further use on-site, such as broken concrete.

Temporary services, such as power, sewer, and water, will be installed to support construction. Water required during construction and on-site potable water will be supplied from two groundwater wells which will be installed for this purpose (Figure 2.1).

Sanitary waste disposal will consist of multiple on-site temporary packaged sewage treatment plants, such as a Bionest™ KODIAK or equivalent system. These systems will be located at the powerhouse, intake structure, and on Rock Island. A typical unit has a capacity of 13,000 litres (L)/day with a 1.5 day retention time. The treatment system will use microbial culture fixed to a synthetic media to facilitate the implantation of the naturally occurring microbial culture in wastewater (Bionest Kodiak 2010). The number and location of these units will be determined during detailed design engineering; however, it is anticipated that multiple units will be required due to the topography of the PDA. Treated wastewater will be discharged to St. John River and will meet discharge criteria specified in the Approval to Construct.

2.4.3 In-Water Work

Although efforts will be made to conduct work in the dry to the extent practicable, some in-water work is unavoidable (*e.g.*, because of its presence on the upstream face of the MQGS). In-water work will include activities related to the removal of loose and damaged surface concrete, and the excavation, sealing of cracks and splits, rehabilitation of the concrete's surfaces, and installation of cofferdams. Concrete repairs will be conducted in the water by divers above and below the waterline. In-water work will be timed to avoid the spring freshet, where practicable. In-water work using divers will only been conducted when safe to do so, taking into account site conditions such as the presence of ice, weather conditions, and water levels.

These activities will occur primarily on the upstream side of the MQGS. In-water concrete repair work is required at the upstream face of the water intake structure, upstream of the gates at the main spillway and diversion sluiceway, the upstream face of the north bulkhead wall, and the exterior walls of the powerhouse. Photo 2.1 shows an example of the concrete repairs required at the upstream face of the water intake structure. The method of concrete repair is described in Section 2.4. Repairs will also be made to the stop log guides at the main spillway and diversion sluiceway.

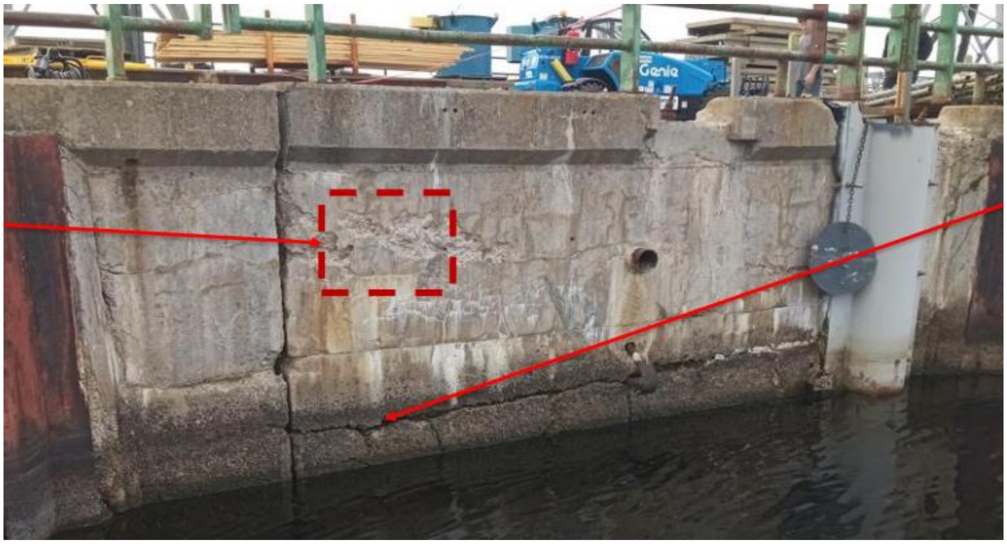


Photo 2.1 Example of concrete repairs required at the upstream face of the water intake structure

Concrete repairs are also required at the main spillway in the stilling basins. The stilling basins require extensive repairs due to scour damage from over 50 years of service, which has caused deterioration and in some places erosion of the concrete. This work will include repairs to the apron and end sill, anchorage, replacement of energy dissipation blocks (baffle blocks), and filling of erosion holes in the riverbed. Additional scour protection may be developed as part of detailed engineering design to reduce future damage to the stilling basins and surrounding bedrock, the details of which would be provided in the *Fisheries Act* authorization and Approval to Construct applications.

This work may be conducted in the dry if feasible (see Section 2.4.3); however, if work in the dry is not feasible, then repairs will be conducted in water using specialized equipment from barges. Underwater hydrodemolition may be used to remove unsound concrete to prepare surfaces for repairs. Steel plates (*e.g.*, sheet pilling, prefabricated steel liners) would be used to provide forms for casting new blocks and apron repairs, using in-water tremie methods. Tremie concrete is used for underwater concrete operations to prevent dissolution of cement product into water. The stilling basins also require anchorage to the river bottom using drilled rebar or pipe anchors. Silt curtains and other mitigation measures will also be implemented to limit the spread of suspended sediment and fines.

2.4.4 Isolated Work in The Dry

Where feasible, areas requiring repairs will be isolated from the St. John River and conducted in the dry. This includes repairs to the main spillway and diversion sluiceway, water intake structure, and powerhouse. For work conducted in the dry, the work area will be isolated from the St. John River both upstream and downstream. Fish present in the isolated area will be removed, where safe to do so, and re-located away from the work area. Water will be pumped from the isolated area using screened pumps and discharged to a lined settling pond.

At the main spillway and diversion sluiceway, repairs to the structures will be carried out in the dry with use of steel cofferdams where feasible. For downstream repairs, the work will be conducted in the dry by installing stoplogs upstream and steel bulkheads at the end of each pier; Photo 2.2 shows a schematic of the proposed configuration. This will enable the rollways and piers to be rehabilitated in dry conditions. While the main spillway is isolated, flow will be re-directed through the diversion sluiceway and/or turbines. During construction, NB Power will maintain the ability to pass the river inflow either through the remaining spillbays or through the turbines. NB Power will develop spilling scenarios as part of detailed engineering design to balance flows. Damaged concrete will be removed using hydrodemolition, drum cutter, or mechanical hammer equipment. Water used for demolition will be collected for treatment.

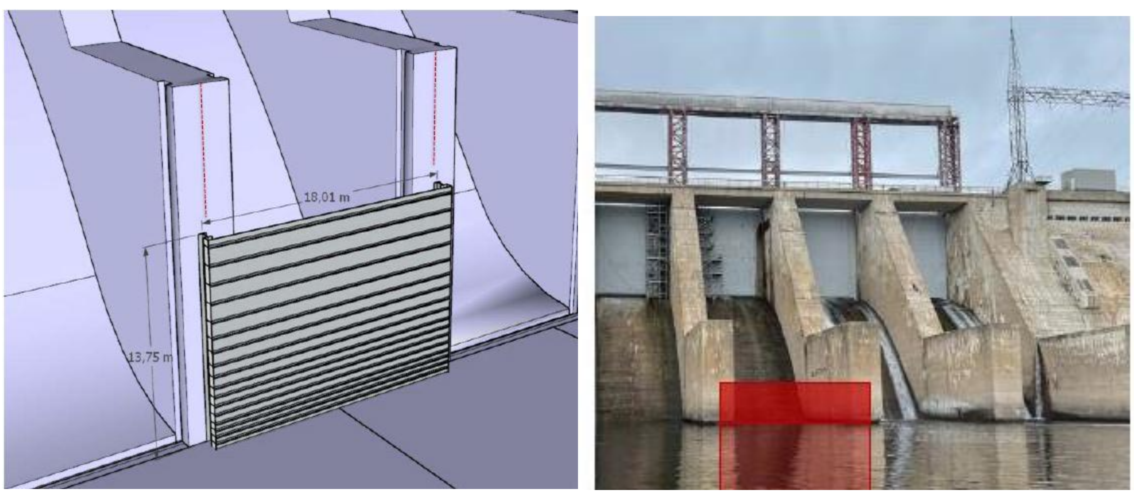


Photo 2.2 Proposed stop log and steel bulkhead at spillway/sluiceway piers

At the water intake structure, the penstock will be dewatered to allow for repairs to be conducted in the dry, in isolation from the river. To isolate the water passage and allow for dewatering, steel bulkheads (*e.g.*, sheet piling) will be lowered into position on the upstream face from the top deck. Once bulkheads are in position, fish remaining in the now isolated area will be rescued and the water passage will be dewatered using pumps or other methods. Flow that would normally pass through the water intake structure will be diverted to the main spillway or diversion sluiceway while the water intake structure is isolated.

Repairs will include the replacement of existing intake gates, guides, and hoist systems, waterproofing and sealing, and local concrete repairs. Replacement work will involve cutting or dismantling these structures into smaller components for removal and recycling and/or disposal at an approved facility. Replacement components will be assembled on site and installed. As described in Section 2.4, damaged concrete may be removed using a combination of hydrodemolition, milling, scarifying, drum cutter, or mechanical hammer equipment. The electrical systems, including high and low voltage equipment, cabling, lighting, and fire detection, will be replaced.

The water intake structure, main spillway, and diversion sluiceway have a total of 22 vertical lift steel roller gates. The AAR concrete growth in these structures has caused the gate's embedded steel roller paths and embedded steel sealing faces to shift outside of their original alignment design tolerances. As a result, gate and seal refurbishment is required as concrete movement is ongoing. After the work areas are isolated, work will consist of in-situ machining of the exposed embedded steel roller paths, sealing faces, and sill and lintel seal faces. Replacement of these embedded steel components may be required.

In the powerhouse water passage, concrete and turbine repairs will be conducted. Concrete repairs will be similar to those described above, and turbine repairs are described in further detail in Section 2.4.5. The steel liner and expansion joint of the penstock will also be inspected and repaired if/as required. Corrosion protection will be applied, and the steel will be sealed to the concrete interface at the inlet. The concrete cover will be replaced.

As described in Section 2.4.2, an underwater portion of the main spillway structure (*i.e.*, the stilling basins) requires extensive repair due to scour damage from over 50 years of service. This includes repairs to the apron and end sill, anchorage, replacement of energy dissipation blocks (baffle blocks), and filling of erosion holes in the riverbed. Additional scour protection may also be developed during detailed engineering design to prevent future damage at the stilling basins and surrounding bedrock. If feasible, this work will be conducted in the dry by dewatering the riverbed basin area. Dewatering would be accomplished by installing steel structures (*e.g.*, structural steel with a series of lift gates) in the water to close off the work area. Any fish remaining within the cofferdam will be rescued so that the area within can be dewatered. The cofferdam structure will be designed so that NB Power retains the ability to release water during high flow conditions if needed.

The spilling basin bays will be partitioned and repaired sequentially. Hydrodemolition may be used to remove unsound concrete to prepare surfaces for repairs. Steel plates will be used to provide forms for casting new blocks and apron repairs, using traditional concrete pouring methods. Drilled rebar or pipe anchors will also be installed to anchor the spill basins to the river bottom.

2.4.5 Work Above the Water Line

Repair activities above the water line will include surface repairs to the slopes and roadways of the main dam, concrete repair work on the upstream faces of the main spillway and diversion sluiceway and water intake structure, concrete repairs and repairs to the superstructure of the powerhouse, and the replacement of bridges and other infrastructure at the main spillway and diversion sluiceway.

The main dam will require surface repairs to the slopes and roadways, consistent with ongoing maintenance, and instrumentation upgrades. Paving will occur throughout the site as part of final site work following the completion of the majority of construction activities, including paving at the main dam, sluiceway bridge, north bulkhead wall, and access road. This work will be conducted using self-propelled earthwork equipment such as bulldozers, excavators, and large trucks, as well as paving equipment.

Repairs planned for the main spillway and diversion sluiceway structures include waterproofing, extensive concrete repairs, replacement of bridges, hoist tower repairs, spill gate and hoist replacement, and upgrades to electrical systems. Waterproofing activities will include sealing cracks and joints from within the drainage gallery (Photo 2.3) to reduce leakage. As described in Section 2.4, damaged concrete may be removed using a combination of hydrodemolition, milling, scarifying, drum cutter, or mechanical hammer equipment.

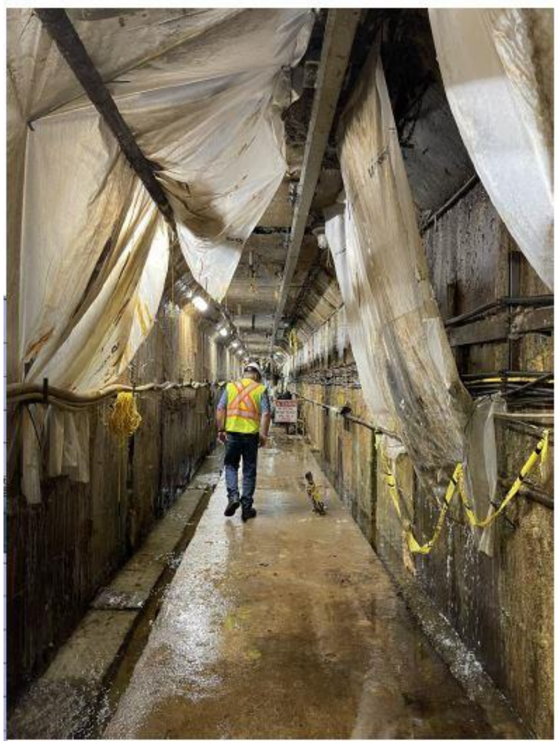


Photo 2.3 Drainage Gallery

The main spillway and diversion sluiceway structure bridges will be replaced. This work will be conducted from the top of the dam and no in-water work is anticipated. It is anticipated that seasonal closures (potentially lasting several consecutive seasons) are likely to be required to enable the Project to be carried out when repairs to the diversion sluiceway bridge deck are being conducted.

The north bulkhead wall and south end pier require concrete repairs to reduce seepage and damaged concrete. Work will include consolidation grouting, replacement of the roadway deck (and associated road closure), anchoring and complete encapsulation the upstream and downstream concrete faces, and installation of a walkway support frame.

At the water intake structure, work will include resurfacing of the top deck and downstream face of the structure and on the upstream face of the structure above the waterline, including deck and curbing refurbishment. Photo 2.4 shows an example of the type of concrete repairs that are required on the downstream face of the water intake structure. Damaged concrete may be removed using a combination of hydrodemolition, milling, scarifying, or mechanical hammer equipment.

Concrete repairs will also be conducted at the base of the transmission line tower, and additional structural steel bracing will be installed.

Photo 2.4 Example of concrete repairs required at the water intake downstream face

Waterproofing will also be undertaken at the water intake structure, including grouting and sealing of existing cracks and joints in the concrete throughout the structure to reduce seepage. Core drilling and pressure grouting techniques will be used. Drill water will be sourced from the St. John River or on-site groundwater wells, and drill wastes will be collected for treatment on-site (see Section 2.4.1).

At the water intake structure, concrete cuts on both sides of each intake water passage will be filled with cement grout. In addition, a grout curtain will be formed between penstocks to reduce water seepage. Core holes will be drilled from the deck surface, and grout will be pumped into the drill holes such that it spreads within fissures in the concrete, preventing water seepage through the structure.

Building components, including the heating, ventilation, and air conditioning (HVAC) system, doors, windows, and staircases will be replaced, and the gantry crane located on the top deck will be replaced upon completion of deck repairs.

Work above the water line at the powerhouse will include concrete repairs to the outside of the building, interior walls and floors, as well as work to reinforce the structural steel superstructure of the building. Other building elements such as roofing, windows, doors, staircases, and fire protection systems may be replaced as necessary.

Concrete repairs inside the powerhouse will include the installation of rebar anchors at locations needed to control AAR movement, injection of structural cracks, and local repairs to floors and walls (see Photo 2.5). Concrete around the turbine equipment will be removed by sawing and mechanical hammer and replaced with new concrete. Drainage pipes, embedded drainage lines, and conduit will require leak proofing and possible replacement. Waterproofing activities will include sealing cracks on walls and floors inside the building, sealing construction joints, and grouting previous saw cuts.

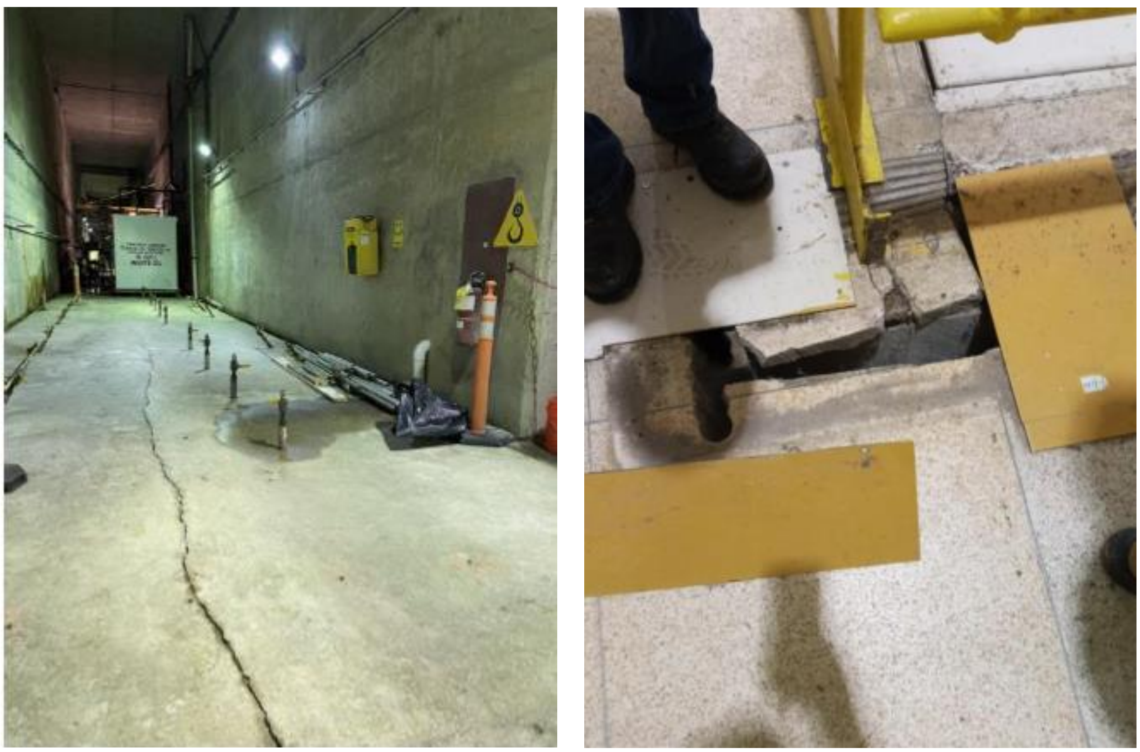


Photo 2.5 Example of concrete repairs required at the powerhouse (floor crack) and generator floor

The majority of the work at the powerhouse will be conducted inside the building and on the tailrace deck. Unit transformers on the tailrace deck will be replaced. Balance of plant electrical systems, including high and low voltage equipment, cabling, lighting, and fire detection will also be replaced. Balance of plant mechanical systems, such as drainage collection, oil/water separators, and fire protection will be replaced.

2.4.6 Shut Down of Power Units

Within the powerhouse, the generation equipment (*e.g.*, turbine, generators, ancillary systems) and control systems will be replaced or rehabilitated, one unit at a time. Each unit rebuild/replacement is expected to last from 1 to 1.5 years, starting in approximately 2027. Existing machinery will be dismantled and removed from the substructure with the powerhouse crane, transported to repair facilities, replaced, or rebuilt on-site.

MQGS consists of six vertical Kaplan turbines with a runner diameter of 6.6 m (22 ft) spinning at 112.5 rpm. Each unit has a maximum power output of approximately 110 MW and a maximum discharge of 396 cubic meters per second (m^3/s). Units 1 through 4 (starting at the north shore) are of late-1960s vintage, and Units 5 and 6 were installed in the 1980s.

The AAR induced concrete growth throughout the powerhouse's main concrete superstructure, or "power-block", has resulted in movements of the concrete surrounding the generators and turbines. These movements have placed all six of the turbines and generators outside of original design tolerance criteria. The turbines and generators are also nearing their originally predicted end of service life.

As part of the Project, turbine and generator components will be replaced. The generation equipment (*e.g.*, turbine, generators, ancillary systems) and control systems will be replaced or rehabilitated. Replacement turbine equipment may include a new turbine distributor. To facilitate replacement activities, the concrete surrounding the turbines spiral case, turbine pit, upper draft tube assembly, and generator foundations will require demolition and replacement through use of power saw cutting, diamond wire cutting, and jack hammering. Replacement concrete will need to be procured and installed in various stages of placement.

Existing machinery will be dismantled and removed from the substructure with the powerhouse crane, transported to repair facilities, replaced, or rebuilt on-site. Studies are ongoing as to the extent of component rebuild vs. replacement, effects of AAR, as well as enhancements to fish passage. Where possible, existing equipment and materials will be repaired and reused. The rehabilitated equipment will be designed to accommodate movements due to AAR and will extend the operating life to 2068. Unit transformers on the tailrace deck will be replaced. The balance of plant electrical systems, including high and low voltage equipment, cabling, lighting, and fire detection will be replaced.

2.4.7 Fish Passage

2.4.7.1 Fish Passage Operation Past and Present

Fish passage at MQGS is subject to a 1968 agreement between NB Power and DFO, which established high-level objectives and responsibilities for fish passage for the duration of the life of the MQGS. Under the terms of this agreement, DFO sets the fish passage objectives and operates the fish passage system, while NB Power keeps the system operational and maintains attraction flow and other operational requirements per DFO's instruction.

The current operational fish passage protocol is limited to the passage of Atlantic salmon, alewife, and blueback herring, though the existing fish collection facility is technically and demonstrably capable of providing passage for other species with unknown efficiency. Alewife and blueback herring are collectively referred to in Atlantic Canada as “gaspereau” which is a colloquial term that remains useful because the two species have similar appearance, though they differ in life cycles and spawning requirements.

Fish passage at MQGS (described in detail in Chateauvert, *et al*., 2018) has been undertaken with an active trap-and-truck system in the upstream migratory direction, with downstream passage being passive and limited to passage through the turbines or through the spillways, since its initiation. Trapped salmon are taken first by truck to the Mactaquac Biodiversity Facility for secondary sorting and are then transported upstream of MQGS by truck and released, either upstream of the Mactaquac Headpond or upstream of the other existing dam structures (*i.e.*, Beechwood and Tobique dams) within the St. John River. The amount of gaspereau transported upstream has varied throughout the life of the MQGS. Since 1995, the formal objective has been to pass 200,000 blueback herring and 800,000 alewife, though the total number of gaspereau passed has often greatly exceeded this amount, and in recent years the practice is to pass all gaspereau captured within the trap. Gaspereau are transported and released directly to the headpond just a short distance upstream of MQGS. The trap-and-truck passage system is operated each year during key migration periods, typically from early-May to the end of November, except when conditions prohibit operation (*e.g.,* periods of high flow, later than normal spring freshet). At present, the operation of the fish collection facility is limited to weekdays and during daylight conditions.

2.4.7.2 MLAP Fish Passage Goals and Objectives

Since 2014, in support of the process to select a preferred option for the future of the MQGS, NB Power and the Canadian Rivers Institute (CRI) have worked collaboratively to identify fish passage issues at MQGS and to determine objectives and methods for addressing these issues for the original three options, and later (beginning in 2016), with a singular focus on the selected preferred option of MLAP. This collaboration, known as the Mactaquac Aquatic Ecosystem Study (MAES) and now in its eighth year, was funded in a 50/50 arrangement between NB Power and the Government of Canada through a National Sciences and Engineering Research Council (NSERC) Collaborative Research and Development (CRD) grant. MAES fish passage projects have resulted in a thorough assessment of past and state-of-the-art fish passage designs used around the world (Linnansaari *et al*. 2015a), a summary of expert advice on fish passage considerations globally and specific to the MQGS (Linnansaari *et al*. 2015b), a science-based assessment of species-specific passage needs including a list of recommended species for priority passage consideration (Linnansaari *et al*. 2016), and a review of the state of fish passage in the St. John River (Chateauvert *et al*. 2018), all of which contributed to the recommendations provided to achieve functional, multi-species fish passage under the chosen MLAP option (Curry et. al. 2018). MAES also facilitated several in-situ observational studies to understand important knowledge gaps related to key species spawning (striped bass – Andrews *et al*. 2017; shortnose and Atlantic sturgeon – ongoing; muskellunge – ongoing) and migration behaviour (*e.g.*, Atlantic salmon – Babin *et al*. 2018; American eel – ongoing and Dixon *et al*. 2018). In addition, there are several active MAES projects that are focused on upstream passage of salmon, gaspereau, American eel, and American shad, and using computational computer modelling to better understand the conditions experienced by downstream migrating fish (Yamazaki, pers comm.).

Through MAES, workshops were held in 2014, 2016, and 2021 which brought together fish passage experts from around the world to discuss the global state of fish passage science and to consider objectives and solutions to the fish passage issues at MQGS (Linnansaari *et al.,* 2015b). A result of these workshops was the recommendation that a key objective for fish passage at MQGS should be a long-term, enhanced, multi-species functional fish passage solution for both upstream and downstream at MQGS. *Functional fish passage* (Linnansaari *et al.*, 2016) is defined as a solution that sustains a healthy, naturally reproducing population based on the principles that:

1. Passage must be safe - minimal stress, injury, and mortality.
2. Passage must be effective - a sustainable proportion of individuals must be passed.
3. Passage must occur with minimal delay - fish must be able to reach their destination within necessary windows of ecological and physiological requirements.
4. Passage must result in the ecological endpoint for migration/movement (e.g., spawning, rearing, emigration, overwintering, etc.) for a sustainable portion of the population.

With the overall objective thus defined, the next step was to identify the list of fish species for passage at MQGS. Although it was generally understood that additional species beyond Atlantic salmon and gaspereau were historically passed upstream of MQGS prior to its construction in 1968, there was not a definitive list. The CRI reviewed all available historical data maintained by DFO and NB Power at MQGS and Beechwood Generating Station, supplemented the historical data with knowledge obtained from studies conducted from 2014 to present, and also initiated discussion with the Wolastoqey Nation in New Brunswick (WNNB). A total of ten diadromous fish species that historically required passage at the MQGS, 12 non-diadromous fish species that exist on both sides of the MQGS, and eight non-native fish species that may be present near MQGS were identified.

In 2018, the CRI, WNNB, DFO, and NB Power reviewed the complete list of fish species known to be present near MQGS and discussed fish passage at MQGS as well as existing fish passage issues. Based on completed and in-progress fish passage studies and workshops, it was agreed that the two most important limiting factors for fish passage at MQGS were:

1. The presence of the headpond creating a barrier to passage, and
2. Mortality associated with the downstream passage through the turbines.

As described in Samways, *et al.*, 2019, a “do no harm” logic was applied to the complete list, and the ten diadromous fish species which historically required passage at that location for critical life-cycle purposes was reduced to six species: Atlantic salmon, alewife, blueback herring, American eel, American shad, and sea lamprey. It was agreed that passage of Atlantic sturgeon, shortnose sturgeon, striped bass, and rainbow smelt would likely result in decreased health of the overall population for these species due to the potential of individuals becoming trapped in the headpond or lost via mortality on the downstream return passage. Other fish species either do not require passage to maintain healthy populations both upstream and downstream of the MQGS but should be passed if present or should not be passed for other reasons (*e.g.*, invasive spread or detrimental changes to populations; Samways, *et al*., 2019). Thus, the continued presence of the MQGS and headpond is the limiting factor in determining which species should be passed and how they should be passed, not solely engineering or financial constraints.

During Project construction, operation of the existing fishway will be affected periodically during the fish passage season, over multiple years because of modifications to the fishway or construction on adjacent structures. Thus, the Project includes two distinct phases for fish passage:

1. Temporary, during Project construction activities (see Section 2.4.6.1).
2. Long-term, for the remaining operational lifespan of the MQGS (See Section 2.5.3).

Each of these phases has distinct operational goals and objectives. During the temporary phase, because the proposed fish passage modifications will not be complete, the fish passage objectives will remain unchanged and continue as described for the present in Section 2.1.1.1. During the long-term phase, the goals and objectives will be modified to initially include all six fish species previously identified, though species and required quantity of passed fish may vary as discussed in the following Section 2.1.1.3.

2.4.7.3 Adaptive Fish Passage Plan

An Adaptive Fish Passage Plan will be developed for the long-term operation of the refurbished MQGS fish passage facility, acting in combination with other NB Power dams on the St. John River. The Adaptive Fish Passage Plan will be developed following an established framework for functional fish passage decision-making (Dolson *et al.*, 2021). The process will focus on answering key questions (*e.g.*, which species, and how many fish), establishing metrics and operating plans, and assessing the outcomes of management options for fish using a quantitative approach. The key benefit of having an adaptive framework is that it will allow for goals, objectives, metrics, and operating plans to change during the lifespan of the operation of the MQGS fish passage facility to accommodate advancements in knowledge, the future expectations of regulators, or changing societal values.

As part of the development of the Adaptive Fish Passage Plan, Indigenous and stakeholder engagement has been and will continue to be carried out, including engaging WNNB and DFO, among others. The information learned from both science and engagement will be applied following the framework for functional fish passage decision making, and will thereby inform the establishment of goals, objectives, metrics, and operating plans for the long-term operation of the refurbished MQGS fish passage facility. It is important to recognize that the long-term phase of fish passage at MQGS will not begin until the completion of the major Project construction activities and as such, there is sufficient time to complete the science and Indigenous/stakeholder engagement to develop the Adaptive Fish Passage Plan. To allow for an Adaptive Fish Passage Plan, the selected fish passage design should include sufficient flexibility to accommodate a reasonably foreseeable set of future conditions.

2.4.7.4 Temporary Fish Passage during Construction

Upstream Fish Passage

Starting in 2014, working in parallel with CRI, NB Power retained the engineering services of Kleinschmidt Associates (Kleinschmidt) to evaluate the conceptual fish passage ideas emerging from MAES through an engineering lens, while also identifying ideas of their own. Both CRI and Kleinschmidt determined that standard, typical, or off-the-shelf solutions for providing temporary upstream fish passage do not exist and must be developed. MQGS presents a unique situation where upstream passage is present and the scope and duration of Project construction activities will affect fish passage over multiple years. It is therefore desirable to identify a solution for upstream passage (while the existing fishway is modified) which can be deployed over multiple seasons and has components that are independent of and not affected by Project construction activities.

Gaspereau migrate early in the open-water season, typically arriving at MQGS in early May and concluding their run in mid- to late-June. The gaspereau upstream migration coincides with seasonally elevated river discharge associated with the spring freshet. The elevated flows and water levels that come with the elevated discharge make in-water construction activities difficult, unsafe, or not possible and so it remains feasible to use the existing fish collection facility to trap and truck gaspereau up to and likely exceeding the 1995 established quantities for alewife and blueback herring until the water levels recede to the point where in-water construction activities can resume in approximately mid-June.

Atlantic salmon typically begin to arrive at MQGS at the end of the spring freshet in early June. Those arriving during the period when the existing fish passage collection facility is still in operation will be moved as they are at present, but because a substantial amount of in-water construction work is required for the duration of the Project, it is not feasible to use the existing fish passage collection facility to pass salmon afterwards (approximately mid-June) and an alternate method is required for the period of mid-June to late-November when the salmon migration period concludes.

Following the initially proposed concept by CRI (Curry *et al* 2018) and a detailed evaluation by Kleinschmidt, it was determined that alternative temporary upstream passage for salmon can be achieved by intercepting upstream migrants with a temporary barrier for collection and transport away from the zone of active in-water construction activities. This is currently planned to occur in the area just downstream of the Mactaquac Biodiversity Facility, which is an ideal location for the implementation of this system (Figure 2.5). The location is far enough downstream of MQGS that the flow fields will be relatively constant regardless of which units are running or if gates are spilling, and salmon caught at the MQGS fish lift are presently trucked to the biodiversity facility. The area also has favorable bathymetry as it is downstream of the gravel bars. It is deep enough to allow for slower water velocities (around 1 metre per second (m/s) at 1557 m^3/s river flow) while being shallow enough to allow for anchorage to the bottom (Kleinschmidt 2022a).

The temporary passage system cannot be installed year-round due to ice, debris, and flow conditions in the St. John River during the winter months and spring freshet. Instead, the temporary upstream passage system will target key migratory periods. It is anticipated that in a typical year of river flows this temporary passage system will be deployable by mid-June, or approximately the time that the existing collection facility is no longer useable due to Project construction activities. Since it is anticipated that the gaspereau passage objective will have been met by this time, the temporary passage system will be designed and operated solely to pass Atlantic salmon. This will have the added benefit of allowing for a larger net mesh size which will reduce drag and allow smaller bodied fish to pass downstream unimpeded.

The current conceptual design consists of a 610 m long floating guidance boom (Figures 2.5 and 2.6) leading from the north bank of the St. John River and running upstream at a relatively shallow angle to the south bank adjacent to the outfall of the biodiversity facility. A floating fish trap will be stationed at the south bank to collect and transport fish to the biodiversity facility. Fish will be sorted by species or size and transferred to holding tanks in the biodiversity facility, or directly into trucks for transport upstream (Kleinschmidt 2022a).

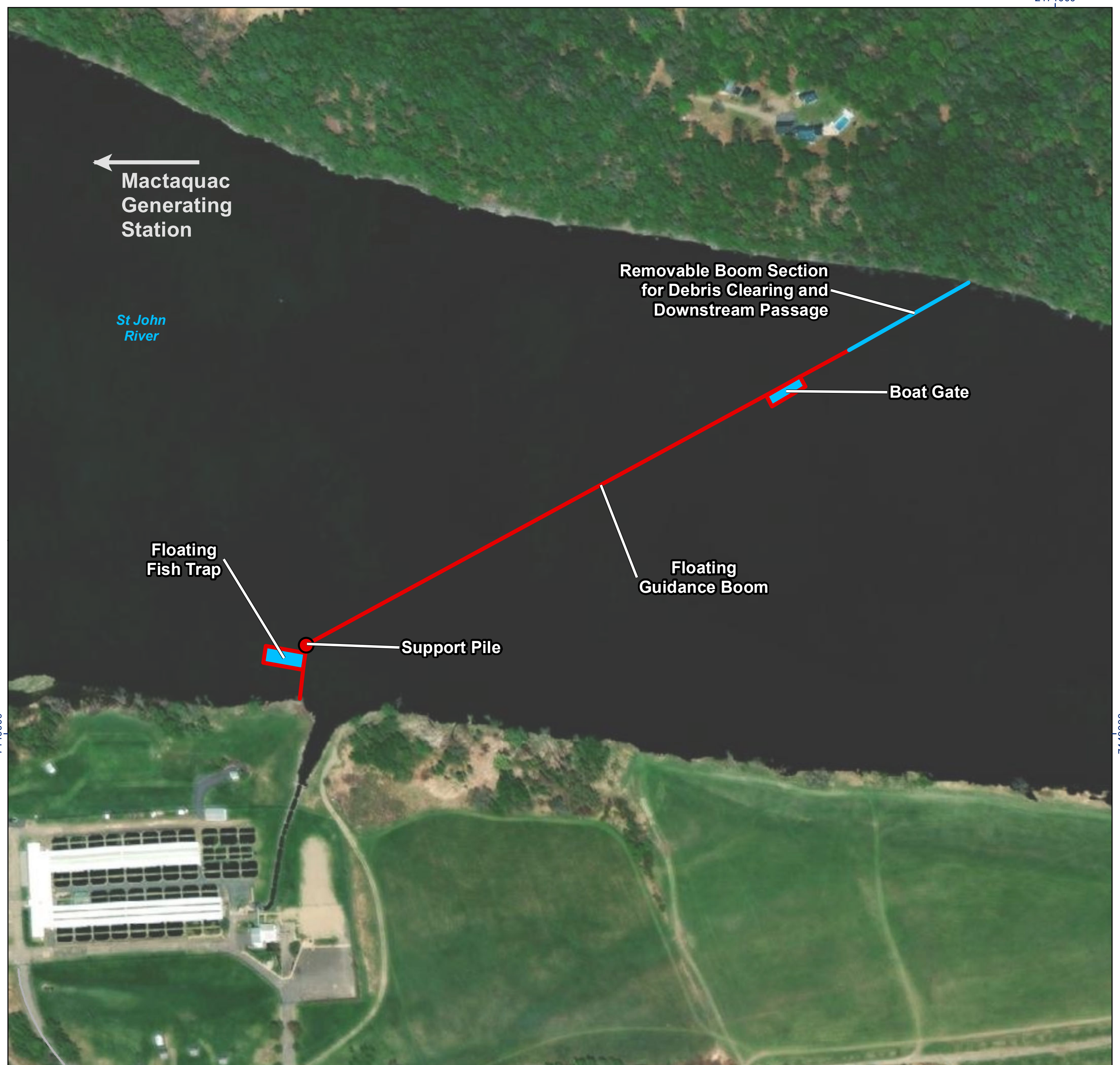
The guidance boom and floating trap will be anchored by concrete ‘deadman’ anchors on both shores. In addition, evenly spaced mass anchors will likely be required along the length of the boom to preserve its geometry (Kleinschmidt 2022a). Provincial and federal permits and approvals (*e.g.*, *Fisheries Act* Authorization, *Canadian Navigable Waters Act* approval, Watercourse and Wetland Alteration Permit) may be required to install and operate the system.

The guidance boom will also act as a surface skimmer for debris drifting downstream. Because the boom will be deployed after the spring freshet, this debris load will likely consist of a continuous but low-density stream of small size debris, which will drift along the boom and accumulate at its downstream corner. A downstream section of the boom will be removable to allow for collected debris to be cleared periodically (Kleinschmidt 2022a).

This downstream extent of the boom will also collect larger-bodied fish (*e.g.*, striped bass, muskellunge and adult Atlantic salmon) that are moving downstream during the upstream passage season and will be designed such that they may be passed or periodically released, potentially by including a section of boom whose suspended screen panels are sized to passively sort the current combination of upstream and downstream migrants (Kleinschmidt 2022a).

The boom will also be equipped with a means, such as a boat gate, to allow boats to pass over it so as not to block transit of small vessels.

2474000



2474000

Temporary Fish Passage

Road

N

0 50 100 metres

(At original document size of 8.5x11)
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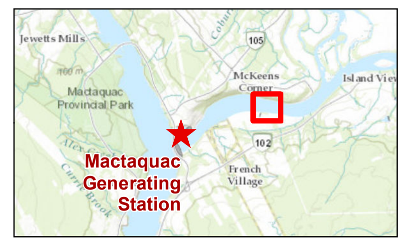
Notes

1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB, Kleinschmidt, Mactaquac Upstream Fish Passage, Design Criteria Description, 5 April 2019
3. Background: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-11-29

Client/Project
121415886_014
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
2.5

Title
Location and Layout of Temporary Upstream Fish Passage Concept

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Figure 2.6 Typical HDPE Floating Guidance Boom by PNP with Flanged Connection (inset) (Kleinschmidt 2022a)

Downstream Fish Passage

During Project construction, downstream passage will continue to occur as it has since 1968, through the turbines or by spill. The temporary passage system will allow downstream passage as described above.

2.4.8 Transportation

Mactaquac Road crosses the St. John River and connects Route 102 (south side) and Route 105 (north side). This roadway has steady traffic volumes (annual average traffic volume of 4,500 vehicles per day; exp 2015). NBDTI is planning a project to carry out repairs to this roadway and bridge over the intake channel in 2023, which is outside the scope of the MLAP.

Project-related vehicle traffic will include non-truck traffic from Project personnel who will commute to and from the Project, as well as heavy truck traffic for the delivery of heavy equipment, bulk materials, and Project components. It is anticipated that the PDA will be accessed from Route 102 and Route 105, and the existing site access road, Powerhouse Road (Figure 2.1).

There are likely to be short-term or intermittent single lane and full closures and disruptions to traffic along Mactaquac Road during the MLAP. When possible, full closure periods will be planned for off-peak hours and outside of tourist seasons; however, seasonal full closures are likely to be required to enable the MLAP to be carried out, especially when repairs to the diversion sluiceway bridge deck are being conducted. A traffic management plan will be developed to identify alternative routes and means of reducing disruptions to traffic, including carpooling strategies, and timing of closures. Transportation closures will be communicated to the public in advance.

2.4.9 Water Access

The MLAP will require access to the St. John River to carry out water-based work, both below and above MQGS. As such, facilities to launch barges and other vessels will be required. Several locations for these water access points are under consideration, and some of these are shown on Figure 2.1 (note that locations are subject to change). Temporary wharf facilities will be installed to provide access to work areas, and for material and equipment handling. Water access structures may include wharves, trestles, or ramps, and may be temporary. These structures would be removed following completion of construction. During in-water work involving divers, it is anticipated that a 10 m x 12 m service barge, 12 m x 21 m work barge with crane, a workboat (tugboat) and a rescue boat will be required for work on both the upstream and downstream sections of the MQGS. For larger operation such area repairs to the stilling basins, multiple barges may be required.

For safety, access to the MQGS property will be controlled during the MLAP. As such, there will be no public access to the river via the MQGS property during the MLAP. Access to the tailrace area in the river will be restricted, for safety.

2.4.10 Water Elevation and Flow Rate

The water elevation in the headpond is normally maintained between 39 m and 40.5 m amsl (128 ft and 133 ft). On occasion, NB Power may be required to lower the headpond water level to a minimum of 37.2 m amsl (122 ft) due to system emergencies, in preparation for extreme precipitation events, or to facilitate maintenance and repairs to the MQGS. NB Power has an established procedure in place to notify the public of any planned or unplanned drawdown of the headpond below (128 ft) normal operating elevations.

Refurbishment of individual spillway bays and their gates will result in the other water conveyances needing to carry the lost potential flow. NB Power will develop protocols for various flow requirements during detailed design engineering so that minimum flow requirements are maintained and flow is balanced through the structure.

2.4.11 Employment and Contracting

The MLAP will require supplies and services from businesses throughout New Brunswick and elsewhere. Local companies (including potentially Indigenous companies) will be sourced to the extent feasible. NB Power will communicate contracting opportunities to local communities in advance to allow them time to respond. It is anticipated that the non-local workforce will make use of existing accommodations locally in the greater Fredericton area. A construction work-camp is not planned.

It is estimated that up to approximately 250 to 350 workers will be required for the MLAP; however, workforce numbers will depend on MLAP detailed design and planning. The total number of workers on-site at any given time will fluctuate throughout the duration of the Project. The expertise of some non-local specialist personnel such as divers, and workers conducting turbine repairs and heavy mechanical work, will be required to complete the Project for specialized activities such as underwater work and turbine and generator replacement.

2.5 OPERATION AND MAINTENANCE

2.5.1 Operation of the Refurbished MQGS

Upon completion of the of the MLAP construction repairs, refurbishments, and equipment replacement, the MQGS will resume normal plant operations per its original design intent. The Project is not intended to result in an increase in generation capacity; however, there may be small increases in generation capacity as the new and/or refurbished generating equipment will have greater efficiency than the existing equipment.

Following construction, the key structures and main water flow conveyances will be fully operational and available for service. As construction of the Project will occur sequentially, units and components may resume normal function before the completion of construction of the entire Project. Replacement of the six Kaplan hydraulic turbines will restore the MQGS's ability regulate water and power per the original design intent. Restoration of the water control through the turbines will also restore the generator power output variability on the previously damaged units. As such, more flexible load-following by the generators, and improved ranges on water flow regulation, will be a small change in the day-to-day operational tasks. Completion of the MLAP project work, however, is not expected to produce any substantial changes or deviations to the MQGS's operations or in how the MQGS is maintained.

Operation of the MQGS following completion of the MLAP is expected to be similar to the current operation. As described in Section 2.0, the MQGS will continue to operate as a run-of-the-river hydroelectric generating station during periods of high flow (*e.g.*, spring and fall), with little change in flow between the headpond and downstream in the St. John River. There is some daily and seasonal storage of water which allows NB Power to fluctuate power generation based on available water and variations in energy demand. Water levels in the headpond will be maintained between 39 m amsl and 40.5 m amsl (128 to 133 ft), and it is expected that water levels in the St. John River will continue to range between 3.0 m and 6.6 m amsl (10 ft to 22 ft) immediately downstream of the Station.

No substantive change in the NB Power workforce compared to current levels is anticipated during operation of the Project.

2.5.2 Maintenance of the Refurbished MQGS

NB Power will develop an asset management plan for the monitoring of the new and refurbished assets to optimize asset service life and replacement.

Maintenance of the MQGS is expected to be very similar to maintenance and work which is presently executed at the MQGS. Maintenance activities could require the periodic shutdown of the intake, individual turbines, draft tubes, or power tunnel. The new facilities are equipped with various control gates and stoplogs are available to isolate various areas throughout the intake and powerhouse from the flow of water. It is possible to continue to operate the new facilities, albeit at a reduced capacity, while some maintenance is occurring (*e.g.*, operating only one of the two turbine/generators); however, there will be times when a full shutdown is required for maintenance or inspections.

Regular turbine and generator inspections will be conducted which will require periodic dewatering of the units. The frequency of these inspections and tests will depend on each component or asset.

Routine AAR concrete-related inspections will continue to be conducted to monitor for AAR growth and stresses as the MQGS continues to age.

2.5.3 Long-Term Fish Passage

Upstream Fish Passage

Studies and workshops conducted as part of MAES have identified that the existing trap-and-truck system has an advantage over other long-term fish passage systems (*e.g.*, volitional bypass fishway) in that it allows for the option of bypassing the Mactaquac headpond in the upstream direction and/or targeting the release of fish at strategic locations that are most beneficial to their populations. It also provides the opportunity for the collection and sorting of fish at MQGS to control which fish species are provided upstream passage, and how many (Linnansaari et. al. 2017).

As part of the Project, NB Power has developed a proposed plan for enhancing upstream fish passage by modifying and expanding existing fish passage infrastructure to enhance performance as well as installing new equipment. In general, these enhancements fall into three groups: performance enhancements, functional enhancements, and refurbishments (Kleinschmidt 2021).

Performance enhancements could include modifications to the existing fish collection system such as changes designed to attract and guide fish through the system more efficiently, reduce crowding, and improve the throughput capacity (fish per day) of the system. This could include increasing attraction flow, which guides fish to the collection system, and replacing or redesigning existing gates and hoppers.

Functional enhancements would expand the capabilities and functionality of the existing system. These enhancements could include adding a new facility to provide upstream passage for juvenile American eel, adding a sorting tank to allow separate handling and management of other species during the gaspereau season, and adding another fish hauling truck to the existing fleet to increase capacity and reduce crowding.

Refurbishments of the existing system could include the repairs and rehabilitation of structural and mechanical components of the existing fish collection system to ensure continued reliable operation of existing infrastructure during the life of the Project. These include replacement of entrance gates, screens, and pumps, as well as concrete repairs.

A separate passage system for American eel is required as this species has never been successfully captured in the existing fish collection facility. Several MAES studies (Dixon *et al* 2018) have identified a large population of juvenile eels attempting to pass at MQGS at locations away from the existing passage facility. A variety of options for collecting eels are being considered, including both fixed and moveable engineered options, and testing of a small-scale ramp prototype began in 2022 (Harrison pers comm). The collection of eels using hand nets is also a supplemental option as it has been proven effective in the previous and ongoing studies and could provide opportunity to involve local Indigenous communities (Yamazaki pers comm).

Downstream Fish Passage

NB Power has worked with CRI and Kleinschmidt to identify and evaluate potential alternatives to enhance downstream fish passage at MQGS (Kleinschmidt 2022b). NB Power's overall objective is to provide downstream passage to an approved list of core diadromous species after implementation of the Project while maintaining the ability to adapt to future changes in target species and their populations. Three alternatives for long-term downstream fish passage are currently being evaluated:

1. Selection of turbine equipment with improved fish survival rates
2. Installation a floating guidance boom and bypass
3. Installation of a floating surface collector

These fish passage enhancements are most applicable to surface-oriented species such as salmonids. An adaptive management plan for downstream fish passage for American eel will also be implemented as this species is not surface-oriented. The adaptive management plan will investigate downstream fish passage mechanisms specific to this species and include studies on eel prevalence upstream of the MQGS and migration timing (Kleinschmidt 2022b).

2.6 DECOMMISSIONING

The purpose of the MLAP is to extend the life of the MQGS to its original end of service life date of 2068. No decision has been made as to the future of the facility after approximately 2068. At the end of its service life, the MQGS will be decommissioned unless it is refurbished or its life is extended. When decommissioning activities are determined to be necessary, they will be completed in accordance with the applicable regulations at that time.

When decommissioning takes place, it is anticipated that this would involve a combination of both the removal of buildings, equipment, and structures, and the infilling of subsurface structures, such as powerhouse foundations. Following decommissioning, the site would need to be stabilized and reclaimed for the desired purpose determined at the time.

Planning and engineering design for decommissioning will be completed towards the end of the Project's life in accordance with the requirements in place at that time. As such, decommissioning is not discussed further in this EIA registration.

2.7 SCHEDULE

For planning purposes, construction of the Project is expected to begin in 2024, but is subject to the receipt of all necessary permits, approvals, and authorizations. According to current planning, an approximate 12-year construction period is anticipated. Each unit rebuild/replacement is expected to last from 1 to 1.5 years, starting in 2027.

Operation of the Project will begin immediately following construction and last until the expected end of service life date of 2068. This end of useful service life could be extended with ongoing refurbishment and repair.

2.8 EMISSIONS AND WASTES

NB Power will meet or exceed the compliance standards outlined in applicable regulations and guidelines with respect to waste, emissions, and discharges from the Project. Where no standards exist, industry best practices will be adopted, where applicable. Volumes of wastes and concentrations of contaminants entering the environment will be reduced through best management practices, following applicable legislation, following NB Power's corporate Environmental Protection Plan (EPP) and mitigation planning including the development of a Project-specific Environmental Management Plan (PSEMP).

2.8.1.1 Air Contaminant Emissions

Air contaminant emissions from the Project will mostly occur during construction. The air contaminant emissions of concern are generally classified as Criteria Air Contaminants (CAC) and include carbon monoxide (CO), nitrogen oxides (NO_X), sulphur dioxide (SO_2), and particulate matter (PM, including its common size fractions PM_{10} and $PM_{2.5}$).

Emissions during construction are generally related to the generation of dust and routine combustion gas emissions from generators and construction equipment. Equipment used for construction will generally consist of trucks, bulldozers, graders, backhoes, cranes, barges, and other heavy equipment, similar to what may be seen on many industrial construction sites. Control measures, such as use of dust suppression techniques, will be used in construction zones as required to reduce fugitive dust, and routine inspection and maintenance of construction equipment will reduce exhaust fumes. Timing of activities to avoid undue nuisance to off-site receptors (*e.g.*, limiting select construction activities to daylight hours) will be implemented as feasible. The burning of waste brush/slash material will not be permitted.

While the Project, once in operation, will be an active industrial site, there will be few air contaminant emissions arising from its operation. There may be nominal CAC emissions from delivery of supplies and equipment to the site and from routine maintenance activities, which should not be measurable above background levels.

2.8.1.2 GHG Emissions

Greenhouse gas (GHG) emissions from the Project will mostly occur during construction. The primary sources of GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and carbon dioxide equivalent (CO_2e). Emissions during construction are generally related emissions from generators and construction equipment. Equipment used for construction will generally consist of trucks, bulldozers, graders, backhoes, cranes, barges, and other heavy equipment, similar to what may be seen on many industrial construction sites.

As a hydroelectric facility, MQGS is an important generator of renewable electricity in New Brunswick, and its continued operation through to its original end of service life date will continue to assist Canada in meeting its obligations and commitments with regards to climate change. Importantly, the continued operation of the MQGS will ensure the continued reliable renewable generation of approximately 670 MW of electricity per year. On average, MQGS produces approximately 1.6 terawatt-hours of energy per year

(NB Power 2016). Based on an industry standard household consumption of approximately 10,000 kilowatt-hours of energy use per year, the MQGS powers approximately 160,000 New Brunswick homes.

2.8.1.3 Noise and Vibration Emissions

Noise and vibration emissions from the Project will occur primarily during construction. Some limited noise may arise during operation and maintenance.

Noise emissions during construction are generally associated with the operation of construction equipment and pile driving. Construction noise will be intermittent, as equipment is operated on an as-needed basis and mostly during daytime hours. Noise sources will be mitigated through the use of mufflers, noise barriers, and timing of activities.

During operation and maintenance, there will be continuous noise emissions from the powerhouse, mostly from the routine operation of transformers, fans, and the turbines. Noise sources will be mitigated through a combination of building design and acoustical barriers or treatment on buildings. There is no expected substantial source of vibration from the Project during operation and maintenance.

2.8.1.4 Liquid Wastes

Liquid wastes generated during construction include oils and lubricants from the construction equipment. These wastes are considered dangerous goods and will be collected and disposed of in accordance with applicable local and provincial regulations. Wastewater generated from hydrodemolition, drilling, grouting, and concrete cutting will be collected and disposed of using an on-site wastewater treatment system (Section 2.4.1). Additional sewage treatment will be needed for the MLAP, and a temporary packaged sewage treatment plant will be installed on-site (Section 2.4.1)

Liquid wastes typically produced during operation and maintenance will be primarily from domestic water use. Various oils and lubricants will also be required to support the operation of transformers, generators, and other mechanical equipment in the intake and powerhouse. Any waste oils and lubricants will be taken to an approved recycling or disposal facility. Liquid wastes during operation and maintenance are anticipated to be similar in volume and characteristics to liquid wastes currently generated by the existing MQGS.

2.8.1.5 Surface Run-off and Sedimentation

There is potential for erosion and sedimentation of freshwater systems associated with land-based construction activities as well as sediment re-suspension associated with in-water construction activities. The EPP and PSEMP will include plans for erosion and sediment control measures. Sediment controls are anticipated to include measures such as the development of settling ponds for storm water management and dewatering activities, silt fences and straw bales on land, and silt curtains for in-water work.

2.8.1.6 Solid and Hazardous Wastes

Non-hazardous solid wastes generated during construction will include concrete and metal demolition debris, brush, temporary fencing, signs, metal containers, canisters as well as scrap metal, excess concrete and other construction materials, and domestic wastes. Scrap paper and other office wastes will also be generated.

Existing hazardous materials at the MQGS may consist of asbestos containing materials and lead containing equipment, paints, and other materials. NB Power will conduct a hazardous materials survey prior to construction to identify the location and nature of existing hazardous materials present at the MQGS. Additional potentially hazardous wastes generated during the Project construction phase may include, but are not limited to, used hydraulic fluids, motor oil, and grease and lubricants for heavy equipment. Hazardous materials required for construction will be stored on-site in separate temporary storage areas provided with full containment.

During operation and maintenance, a limited amount of solid wastes may be generated, such as lubricant containers, or domestic waste.

NB Power will actively cooperate with municipal waste reduction and recycling programs and will encourage conservation throughout construction and operation.

A dedicated waste storage and recycling area will be established for use during construction (Figure 2.1; Section 2.4.1). Dedicated waste materials storage and recycling areas will be located on the NB Power property, as shown on Figure 2.1. Metals will be temporarily stored for reuse or for transport to an off-site recycling facility. This area will also be used for storage and handling of clean concrete from demolition for reuse on site, as well as permanent disposal of clean, inert materials with no further use on-site, such as broken concrete.

The remaining solid wastes will be collected from this dedicated area and disposed of in a manner consistent with local and provincial standards. Hazardous wastes will be removed, handled, and disposed of following provincial and federal regulators and will be disposed of at an approved facility. Non-hazardous wastes will be separated as recyclable and non-recyclable, with recyclable material collected and transported to a licensed recycling facility. An effort will be made to reduce the amount of waste generated by the application of 4-R principles (*i.e.*, reduce, reuse, recycle, recover) to the extent practical. Waste management procedures will be outlined in the PSEMP and comply with provincial solid waste resource management regulations as well as additional municipal and disposal facility requirements. Non-recyclable wastes will be transported off-site to a permitted landfill.

Dangerous goods will be stored on-site in a separate temporary dangerous goods storage area provided with full containment. Dangerous goods will be removed from the site by a licensed contractor and recycled or disposed at an approved facility.

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3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

This chapter provides an overview of the existing environment in which the Project is located. The information used to describe the existing conditions was obtained from:

- Past research, studies, literature review, or assessments conducted in the region, including the Comparative Environmental Review (Stantec 2016)
- Government or other databases
- Field studies and other work conducted in support of the Project

3.1 PHYSICAL SETTING

3.1.1 Topography and Drainage

The topography around the Mactaquac Generating Station (MQGS) is generally sloped towards the St. John River (Wolastoq), with a maximum elevation of approximately 130 metres above mean sea level (amsl) (426.5 feet [ft]), and a minimum elevation of 3 m amsl (9.8 ft) immediately downstream. Near the MQGS, surface drainage is generally from northeast to southwest. The flow direction splits west to Mactaquac Park Arm and south to Chapel Bar on the headland. The topography and flow directions can be seen below in Figure 3.1.

3.1.2 Bedrock and Surficial Geology

The surficial and bedrock geology varies across the Project development area (PDA). Surficial deposits include till, silt, sand, gravel, and bedrock rubble ranging in thickness from less than 0.5 metres (m) to 3 m (Rampton 1984). Bedrock includes greywacke, slate, siltstone, sandstone, conglomerate, limestone, granite, quartz monzonite, granodiorite, and quartzite (Potter *et al*. 1979; NBDNRE 2000).

Figure No.
3.1

Title
Topography

Client/Project 121415886_001

NB Power
Mactaquac Life Achievement Project

Project Location
Mactaquac Generating Station
York County, NB

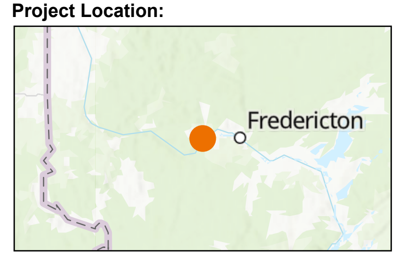
Prepared by NW on 2022-09-01

0 100 200
Metres
(At original document size of 8.5x11)
1:12,000

Legend

- Flow Direction
- Watercourse
- Waterbody
- Contour (10 m)

Project Location:



Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB, Service NB, NB DNR
3. Background: GeoNB, Service NB

Stantec

3.2 BIOPHYSICAL SETTING

3.2.1 Atmospheric Environment

The atmospheric environment consists of three main components: air quality, greenhouse gas (GHG) emissions, and sound quality.

Ambient air quality in New Brunswick is generally characterized as very good, with few exceedances of the provincial ambient air quality objectives and Canadian Ambient Air Quality Objectives (CAAQS). The provincial ambient air quality monitoring station in Fredericton (the nearest air quality monitoring station to the MQGS) has not recorded exceedances of the measured air contaminants between 2015 and 2020, which is the most recently available published data (NBDELG 2017, 2019a, 2019b, 2020, 2021, and 2022). Although air quality is not directly measured at the MQGS, based on the data collected by the New Brunswick Department of Environment and Local Government (NBDELG) throughout the province, only areas that are within close range to large industry tend to record infrequent exceedances of air quality objectives while other stations tend to show full compliance. For more information, see Section 6.2.

The release of GHGs, on a global scale, increases worldwide concentrations of GHGs in the atmosphere. New Brunswick's GHG emissions represented approximately 1.8% of Canada's GHG emissions in 2020 (ECCC 2022a).

The MQGS is located in a relatively rural area. The existing sound pressure levels (noise) is characterized by sounds of nature, vehicular traffic, noise from recreational activities (*e.g.*, boating, camping, all-terrain vehicles), and noise from the existing facility (*e.g.*, noise from water falling over the spillway and noise from the powerhouse).

3.2.2 Water Resources

3.2.2.1 Surface Water

The St. John River is located primarily in New Brunswick and flows approximately 700 kilometres (km) from its origin at the Little St. John Lake in Maine to the Bay of Fundy. Its drainage basin extends from northern Maine and eastern Québec down through western New Brunswick where it drains into the Bay of Fundy. In New Brunswick, there are three hydroelectric generating stations directly on the St. John River: the MQGS, located 19 km upstream from Fredericton; the Beechwood Generating Station, 160 km upstream of Fredericton; and the Grand Falls Generating Station approximately 220 km upstream of Fredericton. There are other generating stations on tributaries to the St. John River.

The St. John River watershed basin occupies an area of 55,100 km^2 and receives an average of 1,077 millimetres (mm) of precipitation per year based on the Canadian Climate Normals (1981 to 2010) for the Fredericton Airport weather station, located approximately 30 km east of MQGS (ECCC 2022b).

There are more than 200 tributaries that flow into MQGS's headpond and transport collected runoff from the drainage area to the St. John River. Major upstream tributaries that flow into the headpond include Meduxnekeag River, Eel River, Shogomac Stream, Longs Creek, Kellys Creek, Nackawic Stream, Pokiok Stream, and Mactaquac Arm. Major downstream tributaries include the Keswick River, Nashwaak River, and Oromocto River.

The St. John River develops a thick layer of ice in the MQGS headpond during the winter months. MQGS prevents the migration of large amounts of ice downstream, thus generally preventing ice jams from occurring in the lower headpond area and downstream.

The St. John River is used as a water supply for municipalities, industry, and fire suppression. Treated wastewater is also released into the river. Water quality in the St. John River has improved since the 1960s, mostly as a result of improved treatment to municipal and industrial wastewater that drains into the headpond area (CRI 2011).

3.2.2.2 Groundwater

Groundwater is held in soil deposits or crevices in underlying rock, with minerals in the rock dissolving into the water. Quality and quantity of groundwater depends on the geology of the region and can vary based on these geological factors.

Groundwater is expected to flow from areas of high elevation to areas of low elevation. Near the MQGS, groundwater will flow from high elevation areas adjacent to the headpond into the headpond. Groundwater then percolates downward and would be expected to move vertically down from overburden to bedrock.

NBDELG has maintained a water well database since 1994, which includes the location, depth, depth to bedrock, static water level, and estimated safe well yield of recorded wells. Water quality information is also included. The average static groundwater level within 1 km of the headpond is 9.4 m below ground surface (bgs), while the average water level for wells within 300 m of the headpond is similar at 10.8 m bgs.

The Nackawic Wellfield Protected Area and Woodstock Wellfield Protected Area are located upstream from MQGS. The City of Fredericton wellfield is located 14 km downstream of MQGS and contains10 groundwater production wells in saturated sand and gravel deposits.

3.2.3 Terrestrial Environment

The St. John River watershed basin extends from northern Maine and eastern Québec down through western New Brunswick where it drains into the Bay of Fundy (CRI 2011). More than 80% of land in the St. John River basin is forested, while the remainder is composed predominantly of agricultural land and open wetlands (NBDOE 2007).

Three ecoregions occupy most of the watershed: Central Uplands in the north; Valley Lowlands in the central and lower portions of the basin; and Grand Lake Lowlands in the lower reaches (NBDNR 2007).

3.2.3.1 Vegetation and Wetlands

Vegetation

Upstream of the MQGS, surrounding the headpond, is the Valley Lowlands Ecoregion. It contains diverse and large groups of vegetative species that are associated with the lowland area encompassing the St. John River. The forest cover of the area includes species like basswood (*Tilia americana*), butternut (*Juglans cinerea*), ironwood (*Ostrya virginiana*), and white ash (*Fraxinus americana*) (NBDNR 2007). Upstream of MQGS are also hardwood forest stands, known collectively as the St. John River Valley Hardwood Forest (SJRHF) (MacDougall and Loo 1998). This forest type is associated with well-drained and calcareous upland and riparian areas with soil that has been deposited over time. This mature stand is dominated by tree species such as sugar maple (*Acer saccharum*), white ash, beech *(Fagus grandifolia*), yellow birch *(Betula alleghaniensis*), and butternut. These forest stands presently occur in small patches which are isolated by widespread agricultural lands (MacDougall and Loo 1998; NBDNR 2007).

Downstream of the MQGS is the Grand Lake Lowlands Ecoregion, which encompasses the Grand Lake Basin, the Oromocto River watershed, and the lower St. John River and its floodplains. This ecoregion has a distinct climate, identified as the warmest in New Brunswick, and has a unique accumulation of southern vegetation species growing in the rich soils, which are dependent on regular flooding (NBDNR 2007).

Wetlands

Wetlands are considered land that is permanently or temporarily submerged or saturated by water near the soil surface and maintains aquatic processes. These aquatic processes are characterized by species of plants that are adapted to wet and poorly drained soil conditions as well as other biotic conditions representative of wetland environments (NBDNRE and NBDELG 2002). In the areas surrounding the MQGS, various types of riparian wetlands occur commonly around tributaries and among forested land. The Mactaquac Stream Basin also includes some larger wetland areas on the headpond, creating several islands in the lower headpond.

Upstream of MQGS, shrub wetland is most prevalent. This mineral rich wetland is characterized by areas of high water table and shrubs like speckled alder (*Alnus incana*). Downstream, freshwater marsh occurs most commonly and is defined by herbaceous plant species like grasses and sedges.

3.2.3.2 Wildlife and Wildlife Habitat

The naturally formed low-lying floodplains and islands of the headpond area that were visible prior to construction of MQGS are now submerged. Upstream of the MQGS is mostly confined by a steep valley wall which makes the transition between upland and water highly distinct. This abrupt transition between land and water, combined with stable water levels, has helped create an environment with little transitional and riparian habitat as well as generally lower diversity compared to the downstream system. While the entire river ecosystem is used extensively by migrating waterfowl, other avian species, and terrestrial species, there are some noteworthy differences in the availability and use of wildlife habitat.

Compared to the headpond, a greater diversity of habitats is found downstream of the MQGS, where a less severe transition between water and upland supports a higher proportion of wildlife habitat. While this difference is due in part to differences in landscape and tidal influence from the Bay of Fundy, the presence of the MQGS is an important contributing factor. Important downstream wildlife habitat features include wetlands, islands, and managed or protected areas.

The headpond of the MQGS is used as a migration route by waterfowl, including sea ducks on their way to northern breeding grounds. Other migrating seabirds, as well as Canadian geese *(Branta canadensis)* and snow geese *(Anser caerulescens)*, also use the headpond area in spring and fall.

Downstream of the MQGS is productive for waterfowl due to its vast floodplains, high spring and fall waters, and large wetland complexes. It is classified as one of the most important areas for breeding and migrating waterfowl in New Brunswick (Carter 1952; Mendall 1958; SJRBB 1973; Burrows and Cormier 2010). The open river is not productive for breeding waterfowl but provides stopover habitat during migration. The transition of habitat between open water, wetland, and land provides breeding and foraging habitats for various species.

Ducks Unlimited Canada (DUC) has been modifying habitat within the St. John River floodplain downstream of MQGS in order to improve habitat for brood-rearing waterfowl. At least 2,000 hectares (ha) of impoundment wetland has been created downstream of the MQGS from DUC within the vicinity of Grand Lake Meadows. These sites are approximately 15% of the St. John River floodplain complex, varying in patch size from 6 ha to 70 ha.

Several islands are located in the headpond, but many more exist downstream of MQGS. An extensive chain of alluvial islands stretches east from the MQGS to the mouth of the Keswick River, Coytown, and further. These islands total 18 km^2 area in total and provide important habitat including community pasture area for cattle, breeding habitat for waterfowl, and a diverse ecosystem of wildlife and vascular plant species. Several avian Species of Conservation Concern (SOCC), including Barrow’s goldeneye *(Bucephala islandica)*, black tern *(Chlidonias niger)*, least bittern *(Ixobrychus exilis)*, and northern pintail *(Anas acuta)* are associated with transitional habitats that occur exclusively in the environment downstream of the MQGS.

3.2.4 Aquatic Environment

The headpond is characterized by a wide main channel with greater depth than downstream of MQGS, resembling a lake with river-like characteristics. The volume of discharge is proportional to what is received from the watershed upstream from runoff, precipitation, springs, and various human inputs. Downstream of the MQGS, the river is fast-flowing with shallow waters that vary based on releases from the dam.

Upstream of MQGS, the headpond has both shallow and deep open water areas which allow for varying temperatures, light, and oxygen levels. Roots and tree stumps in the headpond are used as habitat by Pumpkinseed sunfish *(Lepomis gibbosus)* and minnows which feed on larval insects and snails found in these waters. Chain pickerel *(Esox niger)*, smallmouth bass *(Micropterus dolomieu)*, and other ambush predators also use these areas for hunting.

Littoral habitat in the headpond inhabited by algae, macrophytes, benthic invertebrates, and fish is impacted by water level changes. Reproductive success and shoreline spawning areas can also be influenced by water fluctuations, which can cause stress for species that are unable to cope physiologically with the changes in oxygen.

Aquatic habitats downstream of the MQGS are typical of a large, regulated river environment, characterized by higher velocities (particularly in the area upstream of Fredericton) and lower water depths than those in much of the headpond. The shallower depths enable greater mixing, reduced thermal stratification, and more consistent water temperatures.

A total of 55 fish species have been identified within the watershed of the St. John River (CRI 2011). Of those, 39 species were identified to be present between Beechwood and MQGS. Five non-native species have been recorded in the area, most notably two popular recreational fishing species: smallmouth bass and muskellunge (*Esox masquinongy*). Eleven fish species are diadromous and require both freshwater and marine environments to carry out their life cycles.

There are five species that were historically present but are no longer present between MQGS and Grand Falls. These include American shad (*Alosa sapidissima*), lake whitefish (*Coregonus clupeaformis*), redbreast sunfish (*Lepomis auritus*), sea lamprey (*Petromyzon marinus*), and striped bass (*Morone saxatilis*). There are no recent records of the species that were historically present, and historical presence may have been remnant populations from prior to the construction of MQGS (*e.g.*, striped bass, sea lamprey). As there is no current fish passage for these species over the MQGS, the species listed above are not considered to be present or incidental upstream of the PDA. American eel (*Anguilla rostrata*) was once abundant in the upstream reaches of the St. John River prior to the completion of the MQGS in 1968 (Meth 1973). In the last 50 years American eel abundance upstream of MQGS has declined with few individuals being captured (Bradford *et al* 2016; Gautreau *et al*. 2018), whereas populations below MQGS have remained stable.

3.3 SOCIOECONOMIC SETTING

3.3.1 Economic Activity and Economic Drivers

New Brunswick's economy is largely based on natural resources. Historically, the forestry sector has been the largest economic driver with exports predominantly to the United States, India, and China. Though natural resources fluctuate in gross domestic product and employment levels, the industry remains prevalent. Agriculture is also included in the natural resources sector and is an integral part of the province's economy.

Tourism and communication also contribute substantially, with tourism acting as the catalyst for many transportation, travel, accommodation, and food and beverage services within the province.

Recreation is another key economic driver of New Brunswick, with the area surrounding the Mactaquac headpond providing excellent recreation access by way of the Mactaquac Provincial Park. Boating and fishing are popular recreational activities, with their popularity at the headpond driven by proximity and ease of river access.

3.3.2 Land Use

The St. John River and Mactaquac headpond are tourism destinations and provide tourism-related services and accommodations to the surrounding areas. Around the MQGS headpond are various types of recreation infrastructure for swimming, boating, camping, and golfing. Properties in the area are a mix of commercial, agricultural, industrial, institutional, recreational, residential, and woodland. Waterfront properties are priced higher on average than those inland due to their proximity to water access on the headpond. Agriculture is also prevalent near the river due to fertile land on the nearby floodplains.

The land surrounding the MQGS also includes public parks, recreational zones, and historical areas. The Mactaquac Provincial Park is located directly across the headpond from the MQGS and contains a campground, golf course, and beaches as well as hiking and cycling trails. Kings Landing Historical Settlement is located approximately 18 km upstream from the MQGS and is an outdoor historical museum created in the late 1960s to preserve historical homes near the river. Finally, there are several commercial campgrounds also located along the shores of the headpond which provide additional recreational facilities.

New Brunswick has an elaborate multi-use trail network, which is present throughout the areas surrounding the MQGS. Recreational activities on these trails include walking, hiking, cycling, cross-country skiing, and snowshoeing. There are also six official trails within the Mactaquac Provincial Park, including a wheelchair accessible trail.

Recreational fishing and hunting occur throughout the St. John River basin. Target fish species include smallmouth bass, trout, and muskellunge, while white tailed deer and waterfowl are common game species.

3.3.3 Transportation Infrastructure

There are several highways found within the area surrounding the MQGS including the TransCanada Highway system, three collector highways, six local highways, and four river crossings. Route 2 is a four-lane divided highway which is part of the Trans-Canada Highway system and provides main routes throughout New Brunswick. Route 3 is a two-lane highway which provides a link from the south of the province to Longs Creek, where drivers can then travel to Mactaquac. Routes 102, 104, and 105 are two-lane undivided collector highways that provide access between Fredericton and Mactaquac. Mactaquac Road crosses the St. John River and connects Route 102 (south side) and Route 105 (north side). The road crosses the river on top of the MQGS rock-fill main dam and diversion sluiceway before crossing the left bank approach channel to the powerhouse via a 200 m bridge owned by the New Brunswick Department of Transportation and Infrastructure (NBDTI).

3.3.4 Indigenous Communities

The territory now known as New Brunswick has been inhabited by Indigenous people for more than 8,000 years (THRIVE Consulting 2015). The Wolastoqiyik people have traditionally been concentrated along the St. John River, while Mi'kmaq people have generally been concentrated on the coastlines and interior highlands of New Brunswick. There are six Wolastoqiyik First Nation communities located along or near the river:

- Madawaska (Madawaska Maliseet First Nation)
- Neqotkuk (Tobique First Nation)
- Wotstak (Woodstock First Nation)
- Bilijk (Kingsclear First Nation)
- Sitansisk (St. Mary's First Nation)
- Welamukotuk (Oromocto First Nation)

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4.0 ENGAGEMENT

4.1 OVERVIEW

As New Brunswick Power Corporation (NB Power) investigated options to address the premature end of service life of Mactaquac Generating Station (MQGS), it began a robust program of Indigenous, community, and stakeholder engagement in 2013, with a formal program carried out throughout 2015 and 2016. This was conducted in support of the Comparative Environmental Review (CER) process that informed the selection of the preferred option for the MQGS, and to support an eventual Environmental Impact Assessment (EIA) process. The consultation and engagement program and results are described in the What Was Said Final Report (WWSR; National and CRA 2016). The purpose of that engagement was to inform communities and stakeholders of the various options being considered at that time for the MQGS, and is continuing in support of the EIA process.

The engagement program began in 2013 when NB Power initiated a process to identify potential solutions to solve the premature end of service life at the MQGS. At that time, various options for the future of the MQGS were being considered to address the AAR problem, each with its own social and environmental considerations, and NB Power needed to understand Indigenous, stakeholder, and the public's concerns and interests to inform a path forward. Broad engagement was conducted, as described in the WWSR. The feedback received, in combination with expert scientific and engineering advice, was critical to determining the preferred option for MQGS, now known as the Mactaquac Life Achievement Project (the Project).

At this stage of the Project, the engagement program is designed to support the EIA process, with a focus on the communities, individuals, and stakeholders that may be most affected by the Project – largely those located relatively close to the MQGS.

In general, the engagement process provides opportunities for meaningful engagement with Indigenous communities, other communities, citizens, stakeholders, and regulators during the EIA process. NB Power has provided, and will continue to provide, opportunities through various methods for potentially affected communities to learn about the Project and receive updates as Project planning advances. NB Power will also continue to work with participants to identify and document concerns raised in relation to the Project and its potential effects. The engagement process is intended to be flexible to adapt to the needs and expectations of Indigenous communities and stakeholders, where possible. This chapter focuses on the information shared and feedback received through this process to date.

NB Power is committed to providing meaningful opportunities for ongoing dialogue about the Project with potentially interested or affected parties according to the following objectives:

- Implement an engagement process that New Brunswickers find accessible, meaningful, honest, and credible.
- Achieve awareness about the Project, the process NB Power will follow to collect feedback, and how this public, stakeholder, and Indigenous input has been and will be used to influence decisions.
- Provide sufficient and appropriate contextual information, in an easy-to-understand format, about the Project and its implications.
- Provide participation opportunities for Indigenous communities, the general public, as well as highly engaged and knowledgeable stakeholders.
- Host values-based dialogue about the Project that allows New Brunswickers to contribute based on their own perspective, experience, and what is most important to them.

Keeping all Indigenous groups, communities, and stakeholders involved throughout the Project is a top priority for NB Power.

4.2 ENGAGEMENT WITH INDIGENOUS COMMUNITIES

As an agent of the Crown, NB Power is expected to conduct all its business in a manner consistent with upholding the honour of the Crown and to meaningfully engage and consult with New Brunswick’s Indigenous peoples. The New Brunswick Department of Aboriginal Affairs is kept fully informed of the engagement activities, and regularly attends meetings with NB Power staff.

NB Power is committed to fostering positive and productive relationships with First Nations, and recognizes the distinct value, culture, and importance of First Nations. As NB Power regularly engages and consults on multiple projects, it has developed a Strategic Approach in 2013 for the First Nations Affairs Department. This strategy focuses on building long-lasting and trusted relationships between each Nation and NB Power that, in part, supports effective engagement and consultation of New Brunswick’s Indigenous peoples regarding NB Power’s projects. In support of this strategy, NB Power also developed consultation, relationship, and capacity funding agreements with the Wolastoqey Nation in New Brunswick (WNNB, representing the six Wolastoqey communities), Mi’gmawe’l Tplu’taqnn Incorporated (MTI, representing eight of the nine Mi’kmaq communities), and Peskotomuhkati Nation and meets with them on a regular basis to provide updates on ongoing NB Power projects, including this Project. NB Power also shares Project announcements and invitations to inquire for further information with Kopit Lodge, which has represented the Elsipogtog First Nation since in 2013.

NB Power has been having meaningful conversations with First Nation communities along the St. John River (Wolastoq) about the future of the MQGS since 2013. This involvement has included the following:

- Direct involvement of First Nations staff in NB Power’s First Nations Relations team.
- First Nations expertise and membership on the Comparative Environmental Review Advisory Committee.

- A First Nations Liaison/Field Monitor hired to assist and observe fieldwork including that of the Canadian Rivers Institute (CRI) in relation to the Mactaquac Project, and circulation of field study reports to First Nations Communities.
- Representation from First Nations on the Lower St. John River Community Liaison Committee.

4.2.1 Methods of Engagement

In response to the interest that the six Wolastoqey communities in New Brunswick have expressed, NB Power funded the following activities:

- Development of an internal consultation protocol agreement to assist the six communities in working together with respect to the Project.
- Development of an external consultation protocol agreement between NB Power and the six communities defining how consultation will occur before and after NB Power selects a preferred option.
- Completion of a Traditional Land and Resource Use study by experts selected by the communities.
- Technical analysis of the Comparative Environmental Review and Social Impact Comparative Review by experts selected by the communities.

In addition, NB Power established an informal working group in January 2018 to discuss fish passage options for the Project. The stakeholders included in this working group with NB Power were Kingsclear First Nation, WNNB, and CRI.

Since 2020, NB Power and WNNB have been working toward a Project participation agreement so that Wolastoqey people can share in the economic benefits and environmental stewardship activities should the Project receive approval and be implemented. This may include training, jobs and contract opportunities, among other potential benefits. This agreement is separate from the rights-based Duty to Consult process. This Project participation agreement would provide Project-related benefits for Wolastoqey communities no matter the outcome of the Duty to Consult process.

Monthly meetings between WNNB and NB Power have been ongoing since approximately 2017 and Project updates have been provided. In the spring of 2022, several meetings were held to discuss opportunities for community meetings or events which could be held to share information on the Project in advance of the EIA process. A summary of the Project and summary presentation was provided to WNNB on June 2, 2022, as an update on detailed Project planning and design. Several meetings were held to discuss planning for ongoing engagement and communication plans.

4.2.2 Key Issues and Concerns

The key feedback from the six Wolastoqey communities as understood by NB Power relates mainly to traditional uses. For the Project, Indigenous feedback was based on concerns surrounding the continuation of current impacts on the St. John River.

From the informal working group for fish passage discussion which took place in January 2018, the concerns of the Wolastoqey participants included past, present, and future Wolastoqey use of the

St. John River; how the fish passage could support other species; the creation of new opportunities; and if Wolastoqey fisheries would be negatively affected by fish passage decisions. The working group recommended priority fish species with respect to fish passage, and these species were used to determine the design of fish passage facilities that were incorporated into Project scope.

4.2.3 Ongoing and Proposed Engagement and Consultation

NB Power is committed to ongoing dialogue with Indigenous communities about the Project. NB Power will endeavour to create a joint communications and engagement plan with WNNB that may include:

- Engaging existing community-based consultation coordinators
- Virtual and in-person meetings
- Presentations to Chiefs and councils
- Participation in community events

NB Power will continue to engage closely with Indigenous communities regarding the Project to facilitate meaningful participation in potential economic opportunities, environmental stewardship of the St. John River, including fish passage, and other means that recognize and help restore Indigenous connection to the river.

4.3 ENGAGEMENT WITH STAKEHOLDERS AND THE PUBLIC

As an organization providing an essential service to hundreds of thousands of New Brunswickers, and with installations and generating stations located in all corners of the province, NB Power is committed to communicating and engaging with its customers on all matters that affect them. This includes providing information online through its website and digital channels, through its customer service representatives, through meetings with Indigenous communities and stakeholders, and through regular meetings with NB Power Community Liaison Committees located in various parts of the province.

4.3.1.1 Identification of Communities and Stakeholders

Residents in communities surrounding the MQGS such as Fredericton, Mactaquac, and Woodstock were important for NB Power to engage with in planning the Project.

Stakeholders included those with general interest in the Project, and Fish and Fish Passage Stakeholders, and included:

- Local community members (*e.g.*, residents and property owners)
- Towns/municipalities
- Regional service commissions
- Business/economic stakeholders (*e.g.*, local businesses, business associations, and industry groups)
- Local services (*e.g.*, fire and police departments)
- Research/academic organizations
- Non-governmental organizations, including environmental interest groups
- Recreational organizations

4.3.1.2 Methods of Engagement with Communities and Stakeholders

To reach the broadest audience regarding the MQGS, NB Power uses a variety of tools, platforms, and media to engage with stakeholders and the wider community, described below. Since 2013, this has included 303,000 direct mailouts, more than 7.5 million impressions through paid media, over 375,000 video views, and 2,750 pieces of promotional material such as brochures, information cards, and posters.

Social Media, Earned Media, and Paid Media

NB Power has sought to leverage available channels and create custom content resources to build awareness and understanding and invite participation in its engagement efforts. The following is a list of owned channels and networks leveraged by NB Power for engagement:

- Community Liaison Committee
- NB Power subject matter experts
- Comparative Environmental Review Advisory Committee
- Mactaquac.ca
- Mactaquaction.ca
- NBPower.com
- Twitter: @NBPower
- Facebook: Efficiency NB/Smart Habits
- NB Power customer newsletter
- NB Power bill insert
- President and CEO communications
- Stakeholder email list
- NB Department of Natural Resource and Energy Development homepage
- Posters, brochures, information cards

More than 7,000 individuals participated in the Mactaquaction online survey, and the Project website had over 27,000 unique visitors.

Open Houses and Community Dialogue Sessions

In October 2015, a series of six public open houses were held in communities surrounding the Project to provide an opportunity for residents to learn more about the Project, the options NB Power was considering, and the emerging findings of the extensive studies that were underway at the time to inform the decision. These open houses were held in Fredericton, Mactaquac, Nackawic, and Woodstock, along with a session for NB Power employees and one at St. Thomas University, and more than 960 people participated.

Subject matter experts from NB Power, CRI, Stantec, and Dillon attended to present relevant information, address questions, and capture feedback. A written survey was distributed, comments captured on an idea wall, and people were also encouraged to provide feedback online at Mactaquaction.ca.

In 2016, three community dialogue sessions were held in Fredericton, Mactaquac, and Woodstock with more than 400 participants. The goal of these sessions was to encourage participants to engage in deeper dialogue and provide more targeted input. These were followed by two stakeholder sessions; one for provincial stakeholders as well as one for fish and fish passage stakeholders. There were more than 100 participants in these sessions representing dozens of organizations.

As described in more detail below, open houses will also be hosted by NB Power moving forward to keep the Indigenous communities, stakeholders, and the public informed on the EIA process and maintain a high level of public feedback.

Public Opinion Research

NB Power engaged Corporate Research Associates Inc. (CRA) to conduct public opinion research in advance of and immediately following the public engagement program to support the CER. This helped establish a baseline of awareness across New Brunswick about the Mactaquac Project and informed how the process could best be structured to meaningfully engage as many New Brunswickers as possible.

Meetings, Tours, Presentations, Briefings, and Direct Correspondence

NB Power endeavoured to meaningfully engage all interested individuals, groups, stakeholder organizations, and community leaders where information could be shared and feedback gathered.

In the years preceding and during the public engagement period in support of the CER, NB Power and the extended Mactaquac Project team participated in additional activities beyond the scope of the formal engagement process. This included briefing sessions, presentations, industry conferences, town halls, in-person meetings, academic lectures, and responding to media opportunities. NB Power also engaged with many groups and individuals by phone, email, and in writing. Over 1,500 people were engaged in meetings, presentations, tours, and briefings.

Community Liaison Committee

NB Power established a Community Liaison Committee (CLC) in the Lower St. John River Region. The CLC serves as an advisory group that provides feedback, knowledge, and suggestions to NB Power on operations and Project-related matters. The group has promoted open communication with area stakeholders and provided them with an opportunity to share feedback on community, environmental, economic, or other matters related to both the business of NB Power and the Mactaquac Project.

The CLC meets quarterly, and while the CLC is primarily focused on the ongoing MQGS operations, most meetings include updates on the Project. Members of the CLC are encouraged to share information from the meetings with their networks.

Formal Submissions

Stakeholder organizations and individuals were invited to make formal submissions and provide detailed input on the Mactaquac decision. The following organizations contributed detailed feedback with one or more formal submissions.

- New Brunswick Salmon Council
- Friends of Mactaquac Lake
- Keswick Islands Property Owners Association
- WWF Canada
- Mactaquac County Chamber of Commerce
- Atlantic Salmon Federation
- Nature Conservancy of Canada
- School for Resource and Environmental Studies, Dalhousie University
- Sustainable Energy Group & Transition Town Woodstock

4.3.1.3 Community and Stakeholder Issues and Concerns

Data collected demonstrated that more than 300,000 New Brunswickers were aware of the decision to be made, more than 50,000 New Brunswickers were informed about the options, more than 7,000 participated in the online survey and more than 3,000 directly engaged in person, by attending open houses, dialogue sessions, stakeholder meetings or sessions by request.

Overall, most New Brunswickers agreed that potential environmental effects of the Project were the most important, closely followed by cost to ratepayers. New Brunswickers also shared that any decision about the MQGS should be based on the interests of the entire province, while being sensitive to the most directly affected communities.

The following list includes some of the most important values identified by communities and stakeholders in 2016. While these are not specific to the Project option ultimately chosen, they are still representative of what is most important to New Brunswickers.

- Environmental impacts, followed closely by cost and potential rate impacts
- Improving fish passage
- Renewable energy investments
- Transparent, evidence-based decision making

These priorities influenced the choice of the preferred option for MQGS, and will continue to guide NB Power's decision-making about the Project going forward.

4.3.1.4 Ongoing and Proposed Community and Stakeholder Engagement Activities

NB Power is committed to sharing information with communities and stakeholders during the EIA process and through the duration of the Project. Presentations, open houses, media releases and interviews, online content, letters, and an online survey are among the ways that NB Power will keep New Brunswickers informed about the Project and invite feedback. The communities of Fredericton, Mactaquac, and Woodstock will be particularly involved in this ongoing process, as well as stakeholder groups previously identified.

A future aspect of engagement which will be implemented is public awareness regarding Project-related changes in the transportation network surrounding MQGS. It is anticipated that road closures and delays will occur throughout construction, and NB Power commits to notifying the public in advance by way of online notices, social media, local newspapers, and radio advertisements when disruptions to the transportation network are anticipated.

4.3.2 Engagement With Regulatory Bodies

NB Power has taken a proactive approach to resolve regulatory issues and concerns, and to verify technical requirements in a collaborative manner with federal and provincial regulatory agencies. The objectives of the regulatory engagement process are to provide information needed by regulators to understand the proposed Project and its potential effects; seek information from regulators about potential adverse effects and applicable regulatory requirements to study those effects; to develop solutions to regulatory concerns; and to verify conformance with regulatory guidelines through regular lines of communication.

As part of the fish passage working group analysis conducted in January 2018, a species list of six species for passage was developed, as described in Section 2.4 of this document. NB Power brought this species list to Fisheries and Oceans Canada (DFO) for consideration.

In February 2022, NB Power submitted a Project summary to the New Brunswick Department of Aboriginal Affairs to seek input on Consultation requirements. In April 2022, NB Power provided the Project summary to the EIA Branch of the New Brunswick Department of Environment and Local Government (NBDELG) to request a screening decision to confirm that an EIA registration was required. NBDELG subsequently determined that the Project does requires an EIA registration and review prior to proceeding, based on the scope of work proposed.

4.4 REFERENCES

NATIONAL and Corporate Research Associates (CRA). 2016. *What Was Said Final Report*. Available online at: https://www.nbpower.com/media/689752/what_was_said_report_mactaquac.pdf

5.0 METHODS AND SCOPE

5.1 ASSESSMENT METHOD

This environmental impact assessment (EIA) registration document focuses on valued components (VCs), which are environmental elements of particular value or interest to Indigenous groups, regulators, stakeholders, and landowners. The VCs are selected based on ecological importance to the existing environment, the relative sensitivity of environmental components to Project influences, and their relative social, cultural, or economic importance.

The following VCs are included in this EIA Registration:

- Atmospheric environment
- Vegetation and wetlands
- Wildlife and wildlife habitat
- Water resources
- Aquatic environment
- Heritage resources
- Indigenous communities
- Socioeconomic environment
- Transportation

The Project-related environmental effects are assessed using a standard framework for each VC.

The assessment includes descriptions of how an environmental effect will occur (pathways), the mitigation and environmental protection measures proposed to reduce or eliminate the environmental effect, and the characterization of the residual environmental effects (*i.e.*, the environmental effects that remain after planned mitigation has been applied) of the Project.

Cumulative environmental effects consider the residual environmental effects of the Project with the residual environmental effects of other physical activities for projects or activities that have been or will be carried out. If there is an identified potential for adverse residual environmental effects of the Project to interact cumulatively with the residual environmental effects of other past, present, or reasonably foreseeable future projects or physical activities, these cumulative environmental effects are also described.

All applicable phases of the Project are described in this EIA registration, as are accidents, malfunctions, and unplanned events. The evaluation also considers the effects of the environment on the Project. The significance of residual Project-related environmental effects is then determined. Follow-up measures that are proposed to verify the environmental effects predictions or the effectiveness of mitigation are identified as appropriate.

5.2 ASSESSMENT SCOPE

The scope of the Project to be assessed includes the construction and operation and maintenance phases, and incorporates the following key considerations:

- Identifying the activities and components of the Project
- Predicting and evaluating potential changes to the environment and the likely effects on identified VCs
- Proposing measures to mitigate adverse environmental effects
- Determining remaining residual effects and whether residual adverse effects are significant after the implementation of mitigation measures
- Development of follow-up and monitoring programs, where applicable, to verify both the accuracy of the effects assessment and effectiveness of mitigation measures

For the purpose of this assessment, the scope of the Project includes the major activities described below:

- Construction
  - Site preparation
  - In-water work
  - Isolated work in the dry
  - Work above water line
  - Shut down of power units
  - Fish passage
  - Transportation
  - Water access
  - Water elevation and flow rate
  - Employment and expenditure
- Operation and Maintenance
  - Operation of the Mactaquac Generating Station (MQGS)
  - Maintenance of the MQGS
  - Long-term fish passage

The EIA registration document begins with the description of the Project and the existing environment, which informs the identification of VCs (*i.e.*, the elements of the environment that could be affected by the Project and are of importance or interest to regulators, Indigenous communities, and other potentially affected members of the public or interested parties). Potential Project interactions with VCs are then identified, along with mitigation measures to avoid or reduce adverse effects, and the residual effects (those remaining after mitigation has been applied) are characterized. The residual Project-related environmental effects are characterized using specific criteria (*e.g.*, direction, magnitude, geographic extent, duration, timing, frequency, reversibility, and ecological and socioeconomic context).

Based on the VCs listed in Section 5.1, Table 5.1 presents the VCs assessed in this report, the potential interactions between the Project and the environment, and scoping considerations for each VC.

Table 5.1 Selection of Valued Components

Valued Components	Potential Environmental Interactions	Scoping Considerations
Atmospheric environment	• Change in air quality • Change in greenhouse gas (GHG) emissions • Change in sound quality	Activities will result in release of air contaminant emissions (particularly dust during construction) and may have the potential to affect human and ecological health. Air quality is regulated by the Province of New Brunswick under the *Clean Air Act*. Sound pressure levels and vibration at nearby receptors may increase temporarily during construction which may cause annoyance. Noise is regulated as a contaminant under the *Clean Air Act*. The Province of New Brunswick has set GHG reduction targets as part of its Climate Change Action Plan.
Vegetation and wetlands	• Change in vegetation communities • Change in wetland area or type	Activities or components have the potential to directly or indirectly affect vegetation communities. Wetlands are valued features of the environment, protected by the New Brunswick *Clean Environment Act*, the New Brunswick *Clean Water Act*, and the associated *Watercourse and Wetland Alteration Regulation*. The focus of concern is on the protection of species biodiversity, unique species assemblages, forest habitats, wetlands, and uncommon habitats.
Wildlife and wildlife habitat	• Change in wildlife habitat • Change in wildlife mortality risk	Activities or components have the potential to directly or indirectly affect wildlife and wildlife habitat including species at risk (SAR) or species of conservation concern (SOCC). Protection of species biodiversity for wildlife is administered through the federal *Species at Risk Ac*t, New Brunswick *Species at Risk Act*, and New Brunswick *Fish and Wildlife Act*.
Water resources	• Potential change in surface water flow regime • Potential change in surface water or sediment river • Potential change in groundwater quality/quantity	Activities and components could potentially interact with surface water to result in adverse environmental effects on water quality and quantity. Surface water is an important component to the ecosystem and is integrally linked to several other VCs. Surface water in New Brunswick is regulated under the *Potable Water Regulation* and the *Watercourse and Wetland Alteration Regulation* and other related regulations. Groundwater is important in the hydrologic cycle and provides an important ecological function (*e.g.*, surface water discharge), as well as being the main water supply for the residents of the Fredericton and Mactaquac regions.

Table 5.1 Selection of Valued Components

Valued Components	Potential Environmental Interactions	Scoping Considerations
Aquatic environment	• Change in fish habitat quantity • Change in fish habitat quality • Change in fish health and survival	Activities or components of the Project have the potential to result in a change in fish populations (*i.e.*, mortality) and a change in fish habitat (*e.g.*, loss of fish habitat). Serious harm, defined as any work, undertaking or activity that results in the death of fish, or a permanent alteration or destruction of fish habitat to fish that are part of a commercial, recreational, or Indigenous fishery or fish to support such a fishery, is regulated under the *Fisheries Act.* Ten aquatic SAR/SOCC may be present or have the potential to be present within the LAA. These include six fish species, two mussel species, and two aquatic macroinvertebrates.
Heritage resources	• Change in heritage resources	Heritage resources are those resources, both human-made and naturally occurring, related to activities from the past that remain to inform present and future societies of that past. Heritage resources are afforded protection under a Provincial Act. Heritage resources are relatively permanent, although highly tenuous, features of the environment. Heritage resources are non-renewable and susceptible to loss or damage as a result of ground-disturbing activities. The value of heritage resource sites is measured not only in terms of the individual artifacts they contain but also in terms of the information about the past that might be obtained from studying the artifacts, and their spatial relationship and context within the site and landscape. Of particular importance is the relationship of archaeological materials to the soils in which they are found. Archaeological sites are fragile and the product of unique processes and conditions of preservation. As a result, removing or mixing artifacts and soils from an *in situ* context without scientifically recording that context can result in a permanent loss of information.
Indigenous communities	• Change to Indigenous communities	The Project will result in access limitations to lands and waters adjacent to the MQGS.
Socioeconomic environment	• Change in the socioeconomic environment	The socioeconomic environment may be affected by the loss of access or loss of area available for recreational use; incompatibility with applicable land use plans and/or economic development plans; Project demand for labour; Project expenditures; and demand on housing and temporary accommodations.

Table 5.1 Selection of Valued Components

Valued Components	Potential Environmental Interactions	Scoping Considerations
Transportation	• Change in transportation	Road closures and delays are anticipated to affect the transportation network around MQGS throughout construction. These are in addition to an increase in traffic to/from MQGS due to construction vehicles and workers.

As part of the engagement process for this assessment (Chapter 4), opportunities have been provided for public participation within the local community in the form of presenting information on the Project and obtaining feedback to better understand local interests and concerns. Engagement with Indigenous groups has also been carried out in order to gather feedback on the Project.

Throughout the planning of the Project, NB Power has developed management strategies to reduce the magnitude of potential adverse effects. This environmental assessment employs a precautionary, conservative approach. Conservative assumptions were generally applied to overstate, rather than understate, potential adverse effects. Aspects of the Project have been examined and planned in a careful and precautionary manner to avoid significant adverse environmental effects.

5.3 METHODS

This section describes how the environmental effects assessment has been developed to meet applicable regulatory guidelines.

5.3.1 Assessment Boundaries

5.3.1.1 Spatial Boundaries

The project development area (PDA) encompasses the anticipated area of physical disturbance associated with Project activities and is depicted on Figure 2.1.

The local assessment area (LAA) encompasses the maximum area within which Project effects can be predicted or measured with a reasonable degree of accuracy and confidence. This varies for each VC based on a variety of factors and is described in each VC chapter (Chapters 6 to 14).

5.3.1.2 Temporal Boundaries

Temporal boundaries for the EIA address the potential effects during the Project's construction, operation, and maintenance over relevant timescales. These temporal boundaries are used in the assessment of residual effects and are also considered applicable for the assessment of cumulative effects.

The temporal boundaries for the Project consist of the following phases:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

As described in section 2, decommissioning and abandonment activities are expected to occur at the end of life of the Project, which is anticipated to be 2068. It is not possible to determine with any certainty the potential environmental effects of decommissioning and abandonment activities, nor the regulations and policies that might apply. Therefore, neither the decommissioning and abandonment phase, nor potential activities to be conducted as a part of it, are assessed in detail as part of this EIA registration; they will instead be evaluated in accordance with regulations in place at that time.

5.3.2 Description of Existing Conditions

Existing conditions for each VC are established based on data collected from desktop research analyses, field programs, engagement, and other ongoing/completed studies. An overview of the existing environment is presented using current information about the existing conditions. The existing environmental conditions are described in each of the VC chapters (Chapters 6 to 14).

5.3.3 Assessment of Potential Environmental Effects

The Project's potential effects are assessed in the context of the existing conditions for each VC.

For each potential effect, specific Project activities that may interact with the VC and result in an environmental effect (*i.e.,* a measurable change that may affect the VC) are identified and described.

Mitigation measures that will eliminate, reduce, or control potential environmental effects are identified and described for each VC. Standard mitigation practices most technically and economically feasible were considered for each VC, as well as VC-specific measures.

Following the analysis of environmental effects pathways and mitigation measures, the residual environmental effects (*i.e.,* the environmental effects that remain after mitigation has been applied) are described. Characterizations of residual environmental effects include:

- **Direction:** The long-term trend of the residual effect.
- **Magnitude:** The amount of change in measurable parameters of the VC relative to existing conditions.
- **Geographic Extent:** The geographic area in which a residual effect occurs.
- **Duration:** The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived.
- **Timing:** Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant.

- **Frequency:** Identifies how often the residual effect occurs and how often during the Project or in a specific phase.
- **Reversibility:** Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases.
- **Ecological/Socioeconomic Context:** Existing condition and trends in the area where residual effects occur.

Quantitative measures are developed, where possible, to characterize residual effects. When not possible, qualitive descriptions are considered. Residual environmental effects are those when remain following consideration of mitigation measures. Within each VC chapter, a summary of the specific characterization of residual environmental effects is provided in tabular form. An example summary table is provided below in Table 5.2.

Table 5.2 Example of Summary of Residual Effects Table

Residual Effect		Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Residual Effect 1									
Residual Effect 2									
Residual Effect 3									

KEY
See (*Table number varies by VC*) for detailed definitions

Project Phase
C: Construction
O: Operation and Maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not Applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

5.3.3.1 Determination of Significance of Effects

For each environmental effect, threshold criteria or standards beyond which a residual environment effect is considered significant are identified. The thresholds are defined in consideration of regulatory standards, objectives, or guidelines as applicable to the VC. Where thresholds are not set by guidelines or regulations, a threshold is developed using the measurable parameters established for the VC. The thresholds define the limits of a change in a measurable parameter or state of the VC beyond which it would be considered significant, based on resource management objectives, community standards, scientific literature, or ecological processes. Quantitative thresholds are preferred; however, qualitative thresholds for significance may be used where quantitative thresholds are not practicable.

A determination of significance of Project residual environmental effects is made using thresholds of significance as defined for the VC. Generally, the determination of significance depends in part on the magnitude, geographic extent, duration, timing, frequency, or reversibility of residual effects.

If an environmental effect is determined to be significant, there is further consideration of the likelihood of occurrence of that significant environmental effect.

5.3.4 Effects of the Environment on the Project

Potential effects of the environment on the Project are identified, significance thresholds are determined, existing conditions are described, potential effects analyzed, mitigation measures described, and residual effects characterized.

5.3.5 Assessment of Potential Accidents or Malfunctions

The potential for, and consequence of, the effects of accidents or malfunctions to occur over the life of the Project are described in this EIA registration. The assessment provides a range of potential accident or malfunction event scenarios across all phases of the Project (*i.e.,* construction and operation and maintenance).

6.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS OF THE ATMOSPHERIC ENVIRONMENT

6.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

The atmospheric environment has been selected as a valued component (VC) because the Project may result in emissions of air contaminants to the atmosphere. The atmospheric environment includes air quality, greenhouse gas (GHG) emissions, and sound quality, as described below.

Air quality is defined as the composition of the ambient air, including presence and quantity of contaminants, that may have adverse effects on vegetation, wildlife, or human health. The concentrations of contaminants in the ambient air can be compared to air quality criteria and objectives, which are established to protect the environment and human health. Air quality is highly correlated with local sources of air contaminants, such as industrial facilities or heavy vehicle traffic, with secondary influences from long range transport of air contaminants from distant sources into a region.

The release of GHGs, on a global scale, increases worldwide concentrations of GHGs in the atmosphere, and GHGs are a contributor to climate change (IPCC 2014). Project-based releases of GHGs, mainly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), are typically used as an indicator of the potential environmental interactions with climate change. The contribution of a project's GHG emissions to provincial and national reduction targets can provide additional context. However, it is understood that emissions resulting from the construction and operation of any one project would have a negligible effect on global climate change. The GHG assessment considers emissions of GHGs expressed in the form of tonnes of carbon dioxide equivalent (tCO_2e).

Sound quality is the sound pressure level in the outdoor environment, which is characterized by the type, frequency, and duration of sound. Sound pressure levels are measured in decibels (dB). For environmental assessments where the effect of sound on humans is the focus, an A-weighted dB scale (dB_A) is used to report sound pressure levels as the A weighting most closely mirrors the frequency perception of the human ear.

In this assessment, the potential changes to the atmospheric environment from the Project are considered. The scope of the assessment is based on applicable regulations and policies, professional judgment of the study team, and knowledge of potential interactions.

6.1 SCOPE OF ASSESSMENT FOR ATMOSPHERIC ENVIRONMENT

6.1.1 Regulatory Context

Air Quality

The New Brunswick *Air Quality Regulation* under the *Clean Air Act* regulates air quality in the province. The Regulation and Act provide measures to regulate the release of air contaminants to the atmosphere from "sources", provides testing and monitoring provisions, and establishes permissible ground-level concentrations of specified air contaminants in the ambient air, among other requirements. At the federal level, the main guidance available for managing air quality contaminants is the Canadian Ambient Air Quality Standards (CAAQS) (CCME 2022), developed by the Canadian Council of Ministers of the Environment (CCME) in 2013. The provincial limits for air contaminants and the CAAQS are presented in the tables below.

Table 6.1 New Brunswick Air Quality Objectives

Contaminant	Units	1 hour	8 hours	24 hours	1 year
Carbon monoxide	micrograms per cubic metre (µg/m^3)	35,000	15,000	-	-
Hydrogen sulphide	µg/m^3	15	-	5	-
Nitrogen dioxide	µg/m^3	400	-	200	100
Sulphur dioxide	µg/m^3	900	-	300	60
Total suspended particulate	µg/m^3	-	-	120	70*
Note: *Geometric mean Source: New Brunswick *Air Quality Regulation*					

Table 6.2 Canadian Ambient Air Quality Standards

Contaminant	Units	1 hour	8 hours	24 hours	1 year
Ozone	Parts per billion (ppb)	-	63	-	-
Nitrogen dioxide	(ppb)	60	-	-	17.0
Sulphur dioxide	(ppb)	70	-	-	5.0
Fine particulate matter	µg/m^3	-	-	27	8.8
Note: The CAAQS includes standards for 2015, 2020 and 2025; the 2020 standards are listed above Source: CCME (2022)					

GHG Emissions

Beginning on January 1, 2021, the New Brunswick (NB) Government implemented an output-based pricing system (OBPS) with the *Reduction of Greenhouse Gas Emissions Regulation – Climate Change Act*. The purpose of the NB OBPS is to reduce greenhouse gas emissions over time. The Regulation establishes GHG intensity targets for large industry with emissions over 50,000 t CO_2e per year and a requirement to report their GHG emissions to the Province. Facilities emitting between 10,000 and 50,000 tCO_2e per year are required to report their GHG emissions to the Province but are not required to adhere to reduction targets unless they opt-in to the NB OBPS program.

Federally, industrial facilities that emit more than 10,000 tCO_2e per year are required to quantify and report GHG emissions to Environment and Climate Change Canada's Greenhouse Gas Reporting Program (ECCC 2019).

Sound Quality

There are no sound level guidelines, regulations, or standards established by the Province of New Brunswick for limiting acceptable sound levels, however certificates of approval issued under the *Clean Air Act* for industrial facilities are sometimes used to regulate noise levels for individual facilities.

6.1.2 Spatial Boundaries

The assessment of potential environmental interactions between the Project and the atmospheric environment is focused on a Project development area (PDA) and a local assessment area (LAA).

The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project. The PDA is depicted on Figure 2.1.

The LAA for the atmospheric environment is defined as the area within which the environmental effects of the Project can be measured or predicted, and can be thought of as the theoretical "zone of influence" of the Project on the atmospheric environment. For considering a potential change in the atmospheric environment, the LAA for air quality and sound quality is defined as 1 kilometre (km) extending beyond the PDA, beyond which Project related emissions of contaminants or sound would be indistinguishable from background levels. The LAA for GHG emissions is not defined, as climate change is a global effect.

6.1.3 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects on the atmospheric environment include:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

6.2 EXISTING CONDITIONS FOR THE ATMOSPHERIC ENVIRONMENT

6.2.1 Approach and Methods

To characterize the existing conditions for the atmospheric environment in support of the environmental impact assessment (EIA) registration, existing literature and information was reviewed. Field surveys were conducted in 2016 and 2017 to collect ambient air quality data from within the LAA. Baseline sound monitoring was conducted in September 2022.

The provincial government collects air quality data from monitoring stations located throughout New Brunswick, and air quality monitoring reports are released annually by NBDELG. Stantec used the information in NBDELG's most recent air quality report for the year 2020 (NBDELG 2022) as well as data collected from field surveys to inform the assessment on air quality in the Fredericton and Mactaquac areas in 2016 and 2017.

Provincial and national GHG emissions are reported by ECCC in annual National Inventory Reports (NIR) to the United Nations Framework Convention on Climate Change (UNFCCC). The latest NIR was published in 2022 for the year 2020 and was used as the source of New Brunswick and Canada's existing GHG emissions (ECCC 2022a).

Sources of information used to describe the existing conditions for sound quality include noise guidelines published by the Alberta Energy Regulator (AER; AER 2007) and field surveys conducted near the Project site in April 2015 and August 2022.

6.2.2 Description of Existing Conditions

The following section describes the existing conditions for air quality, GHG emissions, and sound quality.

Air Quality

Based on the most recently available data from NBDELG, ambient air quality in New Brunswick is generally characterized as very good, with few exceedances of the provincial ambient air quality objectives or CAAQS (NBDELG 2021). These instances of poor air quality rarely occur and are only for very brief periods of time. There were 6 exceedances in 2020, which resulted in nine cumulative hours of exceedances. All of the exceedances were short-lived and related to odorous compounds (*i.e.*, hydrogen sulphide [H_2S] and sulphur dioxide [SO_2]) released in Saint John (NBDELG 2022).

There is a provincial ambient air quality monitoring station located in Fredericton, approximately 20 km east from the PDA. There were no exceedances of the provincial air quality objectives (*i.e.*, measurements of nitrogen oxides [NO_x], ground-level ozone [O_3] and fine particulate matter [$PM_{2.5}$]) between 2015 and 2020, which is the most recently available published data (NBDELG 2017, 2019a, 2019b, 2020, 2021, and 2022). The Fredericton air quality monitoring station also measured carbon monoxide (CO) until 2017 and there were also no exceedances.

Although air quality is not directly measured within the LAA, based on the data collected by NBDELG throughout New Brunswick, only areas that are within close range to large industry tend to record infrequent exceedances of air quality objectives while other stations tend to show full compliance. The closest large industrial facility to the PDA is the AV Group pulp mill in Nackawic, located approximately 30 km west from the Project. There is an industry-operated air quality monitoring station at the Nackawic pulp mill that measures SO_2, total reduced sulphur (TRS), and $PM_{2.5}$. There was only one exceedance of TRS in 2019 in Nackawic that lasted one hour. Therefore, it is expected that the provincial air quality objectives are generally met within the LAA for the Project.

The CAAQS records long-term trends for $PM_{2.5}$ and ground-level ozone across Canada. The 2019 CAAQS targets were met at all stations in New Brunswick from data collected between 2015 and 2019 (NBDELG 2017; 2018; 2019a; 2019b; 2020; 2021; 2022).

Air contaminant data was collected within the LAA in 2016 and 2017. The $PM_{2.5}$, total suspended particulate (TSP), H_2S, SO_2, and nitrogen dioxide (NO_2) results are presented below and are compared to provincial legislation and CAAQS limits.

Continuous particulate matter sampling was performed between July 6, 2016 and March 3, 2017 on an hourly basis using a beta attenuation monitoring (BAM) device. The BAM device was converted to measure TSP or $PM_{2.5}$ approximately every 2 weeks (*i.e.*, measured TSP for two weeks, then $PM_{2.5}$ for two weeks and so on). A summary of the results (maximum, minimum, and average 24-hour rolling averaging periods) is presented below.

Table 6.3 2016 and 2017 Total Suspended Particulate Matter Sampling Results – Mactaquac

Sample	Units	Standard	Sampling Results		
		Maximum Permissible Ground Level Concentration of TSP - *Air Quality Regulation – Clean Air Act* (24 hour averaging period)	**TSP Maximum Concentration (24 hour rolling averaging period)**	**TSP Minimum Concentration (24 hour rolling averaging period)**	**TSP Average Concentration (24 hour rolling averaging period)**
TSP	µg/m^3	120	39	1.7	10

Note:
Data were collected between July 2016 and February 2017 just south of the Mactaquac Dam at 45°56'49.3"N 66°52'09.7"W

Table 6.4 2016 and 2017 Fine Particulate Matter Sampling Results – Mactaquac

Sample	Units	Standard	Sampling Results		
		CAAQS Standard for $PM_{2.5}$ (24 hour averaging period)*	**$PM_{2.5}$ Maximum Concentration (24 hour rolling averaging period)**	**$PM_{2.5}$ Minimum Concentration (24 hour rolling averaging period)**	**$PM_{2.5}$ Average Concentration (24 hour rolling averaging period)**
$PM_{2.5}$	µg/m^3	27	18	1.5	5

Notes:
Data were collected between July 2016 and February 2017 just south of the Mactaquac Dam at 45°56'49.3"N 66°52'09.7"W
*The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations

The TSP maximum concentration result (24 hour rolling averaging period) was 39 µg/m^3, which is lower than the New Brunswick *Air Quality Regulation – Clean Air Act* limit of 120 µg/m^3 averaged over 24 hours. The $PM_{2.5}$ maximum concentration result (24 hour rolling averaging period) was 18 µg/m^3, which is lower than the CAAQS limit of 27 µg/m^3 per 24 hour period.

The H_2S, SO_2, and NO_2 sampling results are presented in Table 6.5.5.

Table 6.5 2016 Hydrogen Sulphide (H_2S), Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) Sampling Results – Mactaquac

Sample	***Air Quality Regulation – Clean Air Act*** **Maximum Permissible Ground Level Concentrations in µg/m^3 (24 hour averaging period)**	***Air Quality Regulation – Clean Air Act*** **Maximum Permissible Ground Level Concentrations in ppb* (24 hour averaging period)**	**CAAQS Canadian Ambient Air Quality Standards in ppb (1 hour averaging period)**	**Passive Sampling Results in parts per billion (ppb) (30 day averaging period)**
H_2S Sample 1	5	3.6	Not available	0.04
H_2S Sample 2				0.07
NO_2 Sample 1	200	106	70**	<0.1
NO_2 Sample 2				0.5
SO_2 Sample 1	300	115	60***	0.1
SO_2 Sample 2				0.2

Notes:
Sample 1 and Sample 2 data were collected in January 2016 and September 2016, respectively, just south of the Mactaquac Dam at 45°56'49.3"N 66°52'09.7"W
*The maximum permissible ground level concentrations in ppb were calculated with the following equation: parts per billion = 24.45 X (concentration in µg/m^3)/molecular weight of contaminant
** The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations
*** The 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations

Two 30-day samples were collected for each of H_2S, SO_2, and NO_2. The results were less than 0.5 ppb for H_2S, SO_2, and NO_2. Although the results are not directly comparable to the limits established under the *Air Quality Regulation* and the CAAQS because of the different time averaging periods, the amounts of contaminants in the 30-day samples are sufficiently low that it is not likely that the criteria would have been exceeded.

GHG Emissions

The quantity of GHG emissions released to the atmosphere in Canada in 2020 (the most recently published data from Canada's National Inventory Reports) was 672,000 kilotonnes of CO_2 equivalent (ktCO_2e), of which 12,400 ktCO_2e were released in New Brunswick (ECCC 2022a). Therefore, New Brunswick's GHG emissions represented approximately 1.8% of Canada's emissions in 2020. Canada's contribution to total global GHG emissions (31.5 gigatonnes [Gt] CO_2e) in 2020 was 2.1% (IEA 2021).

Sound Quality

The PDA is located in a relatively rural area. The existing acoustic environment is characterized by natural sounds (*e.g.*, wildlife, wind), traffic along highways and secondary roads, noise from recreational activities (*e.g.*, boating, camping, all-terrain vehicles), and noise from the existing facility (*e.g.*, noise from water falling over the spillway and noise from the powerhouse).

Existing sound pressure levels in the Project area can be estimated based on methodologies published by the AER directive since the contributing factors are based on population density and traffic patterns (AER 2007). According to the AER directive, the average ambient sound level for areas with comparable population densities and distances from heavily travelled roads is estimated to be approximately 45-50 dB_A at night, and 55-60 dB_A during the day (AER 2007).

Noise monitoring data were collected from four noise monitoring sites near the LAA on April 29, 2015. Table 6.6 below lists the measured sound pressure levels.

Table 6.6 April 2015 Measured Sound Pressure Levels - Mactaquac Area

Site	Description	Approximate Distance from the Project	Observed Sounds During the Field Study	Measured Sound Pressure Level – Daytime ($L_{eq\ (1h)}$ dB_A)
1	Kingsclear First Nation - residential and other use, including a school and a church	200 m to the east	Occasional vehicles, birds, occasional dog barking	50
2	Residential area off Route 102	150 m to the south	Vehicles on Route 102 and secondary roads	59 (measured approximately 30 m from Route 102)
3	Residential area on Route 105	700 m to the southwest	Vehicles on Route 105, birds	57 (measured approximately 30 m from Route 105)
4	Residential on Route 105	200 m to the north	Vehicle passes on Route 105, birds	59 (measured approximately 20 m from Route 105)
Note: $L_{eq\ (1h)}$ is the 1-hour Energy Equivalent Sound Level (*e.g.*, a daytime sound level averaged over one hour Source: Stantec 2016				

The daytime measured sound pressure levels ranged from 50 – 59 dB_A. The sites located closer to Routes 102 and 105 experienced higher sound pressure levels due to traffic on the roads, as expected. The measured sound pressure levels were in line with the sound pressure levels expected from the published AER data (55-60 dBA during the day for rural areas with dwelling units 30-500 m from heavily travelled roads) (AER 2007).

Additional noise monitoring data was collected near the LAA in August 2022. The baseline noise monitoring was conducted at the closest residence, which is located approximately 500 m south-east of the MQGS, across the St. John River and approximately 28 metres from Church Street (Figure 6.1).

Figure 6.1 Aerial View of Project Area and Monitoring Location

The noise monitoring results are presented in Table 6.7 below.

Table 6.7 August 2022 Measured Sound Pressure Levels - Mactaquac Area

Date[1]	Day (07:00 – 23:00)		Night (23:00 – 07:00)	
	$L_{eq\ (16h)}$ dB_A	Number of Hours of Data Collection[2]	$L_{eq\ (8h)}$ dB_A	Number of Hours of Data Collection[2]
August 25, 2022	48	10	38	8
August 26, 2022	48	14	40	7
August 27, 2022	38	6	Not available (N/A)	N/A

Notes:
[1] Monitoring began August 15, 2022 at 13:00 and ended August 27 at 13:00; therefore no data are available for the night of August 27, 2022
[2] The number of hours of data collection includes only data without inclement weather conditions, including wind speeds greater than 20 km per hour (km/h), precipitation, and temperature outside of the operating range defined by the manufacturer of the sound level meter (-20 degrees Celsius to +50 degrees Celsius)
[3] $L_{eq\ (16h)}$ is the 16-hour Energy Equivalent Sound Level (*e.g.*, a daytime sound level averaged over the hours 7 am-11 pm; $L_{eq\ (8h)}$ is the 8-hour Energy Equivalent Sound Level (*e.g.*, a nighttime sound level averaged over the hours 11 pm-7 am).

The daytime measured sound pressure levels ranged from 38 to 48 $L_{eq\ (16h)}$ dB_A. The nighttime measured sound pressure levels ranged from 38 to 40 $L_{eq\ (16h)}$ dB_A. The measured sound pressure levels were lower than the sound pressure levels expected from the published AER data (55-60 dBA during the day for rural areas with dwelling units 30-500 m from heavily travelled roads) (AER 2007).

There are no substantive existing sources of ground vibration near the Project; therefore, the existing level of ground vibration in the area of review is assumed to be negligible.

6.3 EFFECTS ASSESSMENT

6.3.1 Assessment Criteria

6.3.1.1 Residual Effects Characterization

Table 6.8 presents definitions for the characterization of residual environmental effects on the atmospheric environment. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not feasible.

Table 6.8 Characterization of Residual Effects on Atmospheric Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to atmospheric environment relative to baseline **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to atmospheric environment relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible –** no measurable change from baseline conditions. **Low –** air quality is slightly affected but is well within the objectives, guidelines or standards; relatively small changes are expected to provincial and national GHG emissions (10,000 tCO_2e or less per year); sound quality is slightly affected but comparable to previously measured background sound pressure levels. **Moderate –** air quality is affected to values that are near, but below, the objectives, guidelines or standards; notable changes are expected to provincial and national GHG emissions (10,000 to 100,000 tCO_2e per year); notable changes are expected in sound pressure levels from measured background sound pressure levels. **High –** air quality is degraded to values that may exceed the objectives, guidelines or standards; material changes are expected to provincial and national GHG emissions (over 100,000 tCO_2e per year); material changes are expected in sound pressure levels from measured background sound pressure levels.
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the PDA **LAA –** residual effects extend into the LAA **Global –** residual effects regarding GHGs extend globally

Table 6.8 Characterization of Residual Effects on Atmospheric Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term** – residual effect extends for less than 1 year **Medium term** – residual effect extends through the construction phase **Long term** – residual effect extends through the operation phase **Permanent –** recovery to baseline conditions unlikely
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not Applicable –** Effect does not occur during critical life stage or timing does not affect the VC **Applicable –** Effect occurs during a critical life stage
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** **Multiple irregular event –** occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

6.3.1.2 Significance Definition

A significant adverse residual effect on the atmospheric environment is defined as follows:

- For a change in air quality, the maximum Project-related ground level air contaminant emissions plus the background levels lead to frequent exceedance of the respective ambient air quality objective, guideline, or standard. Frequent is defined as once per week for one hour objectives, and once per month for 24 hour objectives.

- For a change in GHG emissions, provincial and federal policies and regulations do not identify specific thresholds or standards that could be used to determine significance when assessing the residual effects of a single project's GHG emissions. Project emissions will be ranked as low (10,000 tCO_2e or less per year), moderate (10,000 to 100,000 tCO_2e per year) or high (over 100,000 tCO_2e per year) as presented in the magnitude definition in Table 6.9. The significance of Project GHG emission totals will be determined at the provincial and national jurisdictional boundaries by comparing Project GHG emission totals to provincial and national GHG emission totals.
- For a change in sound quality, noise from Project construction and operation plus the background sounds pressure levels would cause frequent and medium- or long-term annoyance to the nearest residences or to result in likely sleep disturbance.

6.3.2 Potential Project Interactions with the Atmospheric Environment

Activities and components could potentially interact with the atmospheric environment and result in adverse environmental effects on the atmospheric environment. In consideration of these potential interactions, the assessment of Project-related environmental effects on the atmospheric environment is therefore focused on the potential environmental effect listed in Table 6.9. This potential environmental effect will be assessed in consideration of specific measurable parameters, also listed in Table 6.9.

Table 6.9 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for the Atmospheric Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameters
Change in Air Quality	• Project-related emissions of air contaminants, GHGs, and sound	• Ambient concentrations of air contaminants and particulate matter
Change in GHG Emissions	• Project-related emissions of GHGs	• GHG emissions in tCO2e
Change in Sound Quality	• Project-related emissions of sound	• Sound pressure levels in dBA

Table 6.10 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 6.10 Potential Interactions Between Physical Activities and Atmospheric Environment

Project Activities	Change in Air Quality	Change in GHG Emissions	Change in Sound Quality
Construction			
Site preparation	✓	✓	✓
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	✓	✓	✓
Insolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	✓	✓	✓
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	✓	✓	✓
Shut down of power units	-	-	-
Fish passage	✓	✓	✓
Transportation (*powerhouse: transportation of equipment)*	✓	✓	✓
Employment and expenditure	-	-	-
Operation and Maintenance			
Operation of the MQGS	✓	✓	✓
Maintenance of the MQGS	✓	✓	✓
Fish passage	-	-	-
Notes: ✓= Potential interaction – = No interaction			

6.3.2.1 Potential Effects to the Atmospheric Environment During Construction

Without mitigation, the construction of the Project components has the potential to interact with the atmospheric environment in the following ways:

- Air contaminants may be generated from the combustion of fossil fuels (*e.g.,* diesel and/or gasoline) by heavy mobile equipment.
- Fine particulate matter (dust) may be generated by earth moving activities, loading, and dumping of materials (*e.g.,* rock or earth).
- Dust may be generated from demolition of concrete or other structures.
- Noise (unwanted sound) may result from the construction process itself, from use of heavy mobile equipment (*e.g.,* engines, back-up beepers, banging of equipment), and from the use of chisels and pneumatic hammers for concrete demolition.

The construction of the Project also has the potential to interact with the atmospheric environment by the release of GHG emissions (*e.g.,* CO_2, CH_4, and N_2O) generated from the combustion of fossil fuels.

6.1.1.1 Potential Effects to the Atmospheric Environment During Operation and Maintenance

Without mitigation, the operation and maintenance of the Project has the potential to interact with the atmospheric environment in the following ways:

- Air contaminants and GHG emissions (*e.g.*, CO_2, CH_4, and N_2O) may be generated from the combustion of fuels (*e.g.,* diesel and/or gasoline) from heavy mobile equipment used for maintenance activities.
- Noise from mobile equipment (engines, back-up beepers, banging of equipment) will be limited during operation, though transformers in switching stations may result in localized emissions of noise.

6.3.3 Mitigation for the Atmospheric Environment

The following mitigation measures specific to the atmospheric environment have been identified for this Project.

- Vehicle and equipment emissions will be managed by conducting regular maintenance on all machinery and equipment.
- Idling of vehicle engines, equipment, and machinery will be avoided where possible.
- Haul routes will be managed to reduce engine idling and dust.
- Haul distances to disposal sites will be reduced where possible.
- Construction-related fugitive road dust will be controlled through measures such as speed limits on Project-controlled gravel roads and road watering on an as-needed basis.
- Disturbed areas will be revegetated as soon as possible to limit dust emissions.
- Construction activities will be limited to daytime hours as feasible to limit nuisance noise to off-site receptors at night.
- The need for additional noise mitigation will be considered through construction planning and lower noise generating alternatives will be considered where available.

6.3.4 Characterization for Residual Project Environmental Interactions for the Atmospheric Environment

6.3.4.1 Construction

Project-related releases of air contaminants are not expected to exceed provincial or federal air quality objectives or standards during construction. Combustion gases and GHGs are expected to be released from the operation of construction equipment, including trucks, bulldozers, graders, backhoes, cranes, barges and other heavy equipment. Dust is expected to be generated from earth moving activities, loading and dumping of materials, and the demolition of concrete or other structures.

The estimation of air contaminants released from another hydroelectric project were used to conservatively estimate the potential air contaminant emissions from the construction of the MLAP (Nalcor 2009; Stantec 2016). The other hydroelectric project, the Lower Churchill project, includes the construction and operation of two hydroelectric power generating facilities, while the MLAP consists of rehabilitation activities to the existing MGQS, and its operation. Therefore, the Lower Churchill project is expected to release more air contaminants compared to the MLAP since there would be more construction activities required.

The annual emissions from the operation of construction equipment at the Lower Churchill project, as a conservative indicator of potential air contaminant releases from the MLAP, are presented below, along with a comparison to the total New Brunswick emissions in 2020 (most recently available data).

Table 6.11 Estimated Air Contaminant Emissions

Air Contaminant	Estimated Annual Emissions from the Lower Churchill Hydroelectric Project (Used as a Conservative Surrogate for the MLAP) in kilotonnes (kt)	New Brunswick Total Emissions, 2020 in kt
Total Particulate Matter (PM)	0.133	164.2
Nitrous oxides (NO_x)	1.897	23.7
Carbon Monoxide (CO)	0.409	110.1
Sulphur Dioxide (SO_2)	0.155	12.5
Source: Nalcor 2009, Stantec 2016, Government of Canada 2022		

Overall, under the assumption that emissions from the MLAP are lower in terms of order of magnitude to those expected from the Lower Churchill project, total air contaminants released to the atmosphere are expected to be small in comparison to annual emissions released from other sources in New Brunswick (*i.e.,* the estimated annual emissions from the Lower Churchill project were between 0.1 and 8 percent of what total New Brunswick emissions were in 2020). Therefore, with the mitigation measures employed, the release of air contaminants during construction are not expected to be substantive or contribute measurably to existing ambient levels as they are projected to be moderate in magnitude and irregular (transient) in frequency beyond the PDA.

The construction of the Project also has the potential to interact with the atmospheric environment by the release of GHG emissions (*e.g.*, CO_2, CH_4, and N_2O) generated from the combustion of fossil fuels. To estimate these emissions, GHG emissions from other hydroelectric projects were prorated on a tCO_2e/megawatt hour basis to estimate the total GHGs from construction activities (BC Hydro 2012; Nalcor 2009; Stantec 2016). On this basis, the GHG emissions are estimated to be less than 152,000 tCO_2e over the entire construction period, which will occur over a period of approximately 12 years. This amount is small in comparison to other industrial sources of GHG emissions in NB, and would result in approximately 10,000 – 15,000 tCO_2e per year, depending on the length of the construction period. Therefore, with the mitigation measures employed, the release of GHG emissions during construction are expected to be moderate in magnitude and irregular in frequency.

Construction activities can cause undesirable increases in sound quality for nearby receptors. Construction noise will generally be associated with the operation of construction equipment. There will be no blasting during construction; however, some pile driving is expected and this is anticipated to be the noisiest activity. Pile driving will occur in the water, on the downstream side of the MQGS, in several locations. Typical sound pressure levels of some commonly used construction equipment, including pile drivers, are presented below.

Table 6.12 Typical Sound Pressure Levels of Construction Equipment

Construction Equipment	Sound Pressure Level (dB_A) at 15 Metres Away from the Construction Equipment
Front Loader/ Backhoe/Tractors/Diesel Truck	85
Generators/Pumps/Compressors	77
Impact Pile Driver (Peak Sound)	97
Source: A combination of manufacturer's data, theoretical prediction, and measurements	

Pile drivers, at peak sound, are louder than other types of construction equipment. The daytime sound pressure levels from pile driving activity, assuming it is located at the edge of the PDA that is closest to the nearest residence is estimated to be 64 $L_{eq\ (1h)}$ dB_A. The closest residence to the Project is depicted in Figure 6.1. The distance between the edge of the PDA and the closest residence is approximately 620 metres. Sound pressure levels decrease with increased distance from noise-producing activities. As noted in Table 6.7, the existing baseline sound pressure levels at the closest residence were between 38 and 40 $L_{eq\ (8h)}$ dB_A in August 2022.

Based on the preliminary estimates, without mitigation, the nearest residence may perceive more than a doubling in ambient noise during pile driving activities which may cause annoyance during peak noise generating activities. An increase of 10 dB_A is generally perceived as a doubling of noise by the human ear. This is a preliminary estimate since specific details of which construction equipment will be used, and their daily operating schedules are not yet available. Construction noise is typically intermittent, fluctuates during active construction, and will generally be confined to the LAA and during daytime hours only. Existing nighttime sound pressure levels are not expected to be affected as construction is planned to be limited to daytime hours, to the extent feasible. Mitigation will include additional review of noise management as further construction details become known, including consideration of lower noise generating equipment or construction methods as needed to limit annoyance to nearby residents. Therefore, with mitigation measures employed, changes in sound quality during construction are expected to be moderate in magnitude, and irregular in frequency beyond the PDA.

6.3.4.2 Operation

No substantial emissions of air contaminants or GHGs are expected to occur during operation and maintenance of the Project. Operation and mitigation activities that could release air contaminants or GHGs would include the use of heavy equipment or mobile equipment. Because the operation of the Project produces electricity without the combustion of fuels, the release of air contaminants and GHG emissions by the Project during operation is very low compared to other available options for electricity generation. Although there will be some limited GHG emissions from fuel burning for maintenance activities at the MQGS during operation and maintenance, these emissions are not expected to be substantive, or discernible in the provincial context.

Hydroelectric power is a source of renewable energy. Renewable energy sources are an integral part of Canada's climate plans and targets. The federal government has committed to achieving a 40-45% reduction in GHG emissions below 2005 levels by the year 2030. Canada's long-term plan is to achieve net-zero emissions by the year 2050 via the *Canadian Net-Zero Emissions Accountability Act* (ECCC 2022b. As such, the continued operation of the MQGS through to its original end of service life will assist Canada in meeting its obligations and commitments with regards to climate change. Therefore, the residual environmental effects relating to change in GHG emissions for operation of the Project are considered to be both adverse (as there will be small amounts of GHG emissions from the operation of maintenance equipment) and positive (as the Project is a rehabilitation of a major source of renewable energy), but of low magnitude.

No substantial emissions of noise are expected to occur during operation and maintenance of the Project. The level of noise in the LAA during operation is expected to be comparable to the existing level of noise in the LAA (described in Section 6.2.2).

6.3.4.3 Summary

A summary of the residual environmental effects on the atmospheric environment during Project construction and operation and maintenance is provided in Table 6.13.

Table 6.13 Project Residual Effects on Atmospheric Environment

Residual Effect	Residual Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Air Quality	C	A	M	LAA	MT	NA	IR	R	D
	O	A	L	LAA	LT	NA	IR	R	D
Change in GHG Emissions	C	A	M	G	MT	NA	IR	I	D
	O	A/P	L	G	LT	NA	IR	I	D
Change in Sound Quality	C	A	M	LAA	MT	NA	IR	R	D
	O	A	L	LAA	LT	NA	IR	R	D

KEY

See Table 6.8 for detailed definitions

Project Phase:
C: Construction
O: Operation and maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area
G: Global

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

6.4 DETERMINATION OF SIGNIFICANCE

With the implementation of mitigation and environmental protection measures as described in this assessment, it is not anticipated that the residual adverse environmental effects of the Project on the atmospheric environment will result in exceedances of air quality objectives, guidelines or standards, or material changes in provincial and national GHG emissions. Exceedances of AER directive and previously measured background sound pressure levels may occur during construction; however, the noise is expected to fluctuate, be intermittent, and will generally be confined to the LAA during daytime hours. The residual environmental effects on the atmospheric environment are predicted to be not significant for the Project.

6.2 FOLLOW-UP AND MONITORING

A dedicated follow-up and monitoring plan is not required for the atmospheric environment to verify the environmental effects predictions of the assessment or to verify the effectiveness of mitigation.

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7.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON VEGETATION AND WETLANDS

This chapter provides an assessment of potential environmental effects of the Project on vegetation and wetlands. Vegetation includes vascular plants, non-vascular plants (*i.e.*, bryophytes), and lichens. Wetlands are defined in federal and provincial policies as land permanently or temporarily submerged or saturated by water near the soil surface, for long enough that the area maintains aquatic processes. These aquatic processes are characterized by plants that are adapted to saturated soil conditions, wet or poorly drained soils, and other biotic conditions found in wet environments (Government of Canada 1991; NBDNRE and NBDELG 2002).

7.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

Vegetation and wetlands have been identified as a valued component (VC) because of their intrinsic values and because these features are valued by the people of New Brunswick (NB) for environmental, recreational, aesthetic, and socioeconomic reasons. They are also valued in their relationship with water resources, wildlife and wildlife habitat, and other biological and physical components addressed as VCs in this EIA Registration. Some wetlands and plants are protected by federal and provincial legislation and/or are addressed by federal and provincial policies. In addition, species at risk (including plants) are protected under federal and provincial legislation (pursuant to the federal *Species at Risk Act* [*SARA*] and the New Brunswick *Species at Risk Act* [NB *SARA*]).

The vegetation and wildlife VC is also linked to:

- Wildlife (Chapter 8) – changes to vegetation communities can affect wildlife, which use these vegetation communities for food and habitat
- Water resources (Chapter 9) – changes in water resource use have the potential to affect riparian habitats, including wetlands
- Indigenous communities (Chapter 12) – gathering of traditional plant species may occur within the LAA

7.2 SCOPE OF ASSESSMENT FOR VEGETATION AND WETLANDS

7.2.1 Regulatory Context

The Project is subject to both federal and provincial legislation and policies. This section identifies the main regulatory requirements and policies which influence the scope of the assessment on vegetation and wetlands and govern the management and protection of vegetation and wetlands in Canada and New Brunswick.

7.2.1.1 Federal

Species at Risk Act

The federal *Species at Risk Act* (*SARA*) provides protection for species at risk (SAR) in Canada that are listed on Schedule 1 of *SARA* (Government of Canada 2022). The legislation provides a framework to facilitate recovery of species listed as Threatened, Endangered, or Extirpated and to prevent species listed as Special Concern from becoming Threatened or Endangered. *SARA* provides protection for both SAR and their critical habitat or residences by prohibiting: 1) the killing, harming, or harassing of Endangered or Threatened SAR (sections 32 and 36); 2) the destruction of critical habitat of an Endangered or Threatened SAR (sections 58, 60, and 61); and 3) damage or destruction of residence of SAR (section 33 of *SARA*). *SARA* is co-administered by Environment and Climate Change Canada (ECCC), Parks Canada Agency, and Fisheries and Oceans Canada (DFO), and prohibitions generally apply on federally regulated lands or designated critical habitat elsewhere.

Federal Policy on Wetland Conservation

A federal mandate for wetland conservation is provided by the Federal Policy on Wetland Conservation (Government of Canada 1991). Policy goals are intended to apply on federal lands and waters or to federal programs where wetland loss has reached critical levels. They also apply to federally designated wetlands, such as Ramsar sites, of which there are none affected by the Project.

7.2.1.2 Provincial

New Brunswick *Species at Risk Act*

The New Brunswick *Species at Risk Act* (NB *SARA*) provides for the protection, designation, recovery, and other relevant aspects of conservation of SAR in New Brunswick, including habitat protection. NB *SARA* facilitates the conservation and management of wildlife species to prevent further declines and promote recovery. NB *SARA* is administered by the New Brunswick Department of Natural Resources and Energy Development (NBDNRED).

New Brunswick Wetlands Conservation Policy

Wetlands in New Brunswick are managed by the New Brunswick Department of Environment and Local Government (NBDELG), and their management is guided by the New Brunswick Wetlands Conservation Policy (NBDNRE and NBDELG 2002). This policy aims to protect wetlands through securement, stewardship, education, and awareness, and to maintain wetland function within New Brunswick.

New Brunswick *Clean Water Act*

The New Brunswick *Clean Water Act* (90-80) protects wetlands (and indirectly, wetland plants) through the *Watercourse and Wetland Alteration (WAWA) Regulation*. The WAWA regulation requires a permit for any activity that will result in an alteration to a wetland that is over 1 ha in size, or contiguous with a watercourse. The application of this policy and the requirements for wetland assessment in New Brunswick have changed throughout the last decade. Typically, if permitting is required under the WAWA regulation, compensation will be required for wetland loss at a ratio of 2:1.

New Brunswick *Clean Environment Act*

Wetlands are also a trigger under the *Environmental Impact Assessment Regulation* (EIA) of the New Brunswick *Clean Environment Act*. Under this regulation, disturbance to wetlands that are 2 ha in size or greater is a trigger for a provincial EIA.

7.2.2 Species at Risk and Species of Conservation Concern

With respect to vegetation, this VC focuses on Species at Risk (SAR) and species of conservation concern (SOCC). SAR include those listed as Endangered, Threatened, or Special Concern by the federal *SARA*, NB *SARA*, or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC assesses and designates the status of species and recommends this designation for legal protection under *SARA*. On lands under provincial jurisdiction, federal *SARA* goals are typically reflected through provincial legislation, policy, and guidelines.

SOCC are those species that do not meet the above definition of SAR, but are considered rare in New Brunswick, or the long-term sustainability of their populations has been evaluated as tenuous. SOCC are defined here as non-SAR species ranked S1 (Critically Imperiled), S2 (Imperiled), or S3 (Vulnerable) in New Brunswick by the Atlantic Canada Conservation Data Centre (AC CDC) (AC CDC 2022a). SOCC are included in this VC as a precautionary measure, reflecting observations and trends in their provincial population status, and are often important indicators of ecosystem health and regional biodiversity. Rare species are often an indicator of the presence of unusual and/or sensitive habitat, and their protection as umbrella species can confer protection on their associated unusual habitats and co-existing species.

While some species included as SAR in this assessment currently have regulatory protection as they are listed under Schedule 1 of the federal *SARA* or the *Prohibitions Regulation* of NB *SARA*, the definition above also includes those species on the NB *SARA List of Species at Risk Regulation* and those listed by COSEWIC that are candidates for further review and may become protected (covered by prohibitions) within the timeframe of this Project.

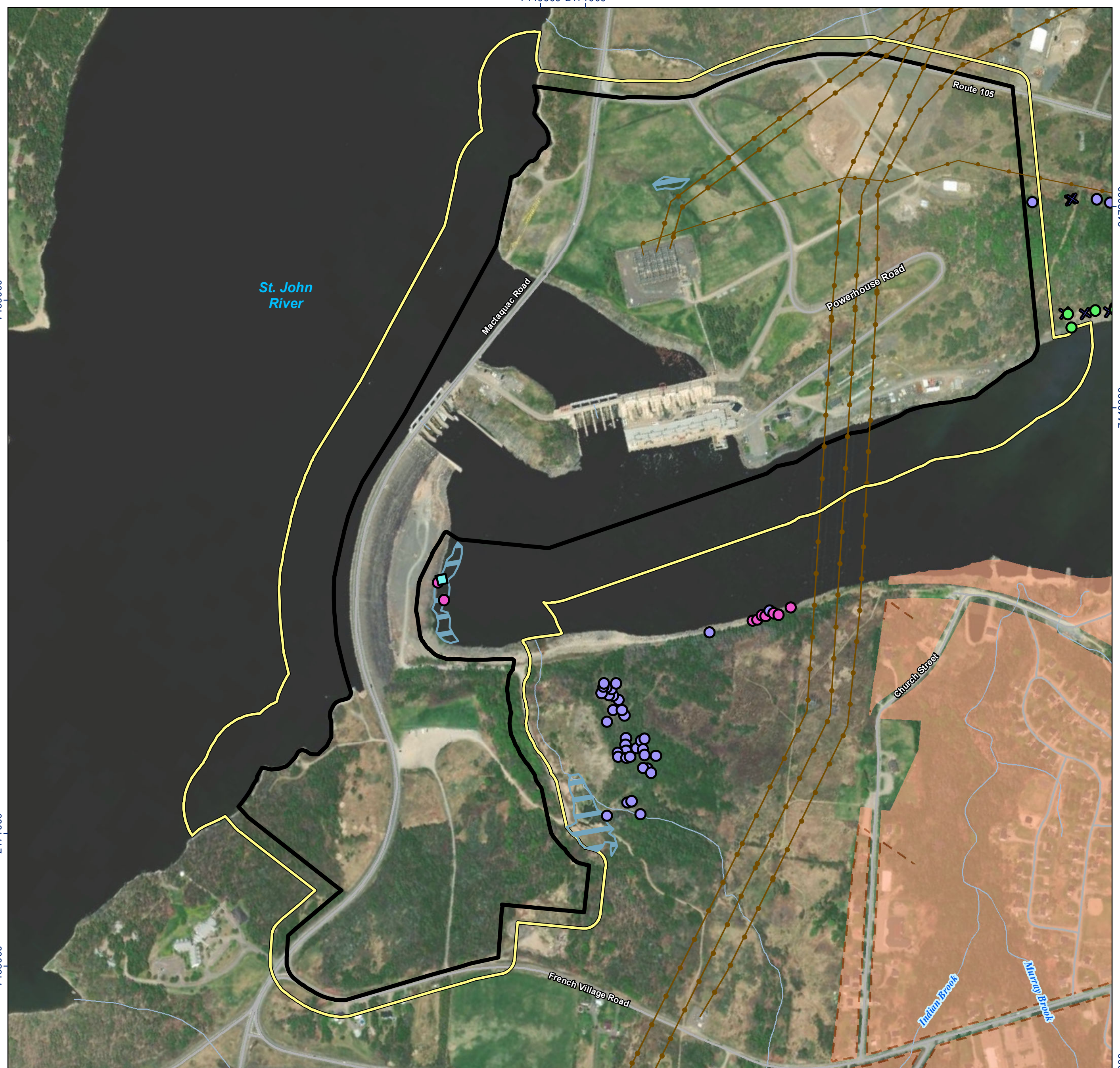
7.2.3 Spatial Boundaries

The assessment of potential environmental interactions between the Project and vegetation and wetlands is focused on a project development area (PDA) and a local assessment area (LAA).

The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project. The PDA is depicted on Figure 2.1.

The LAA for the vegetation and wetlands is defined as the area within which the environmental effects of the Project can be reliably measured or predicted. For considering a potential change in vegetation and wetlands, the LAA for vegetation and wetlands includes a 30 m buffer of land-based components of the PDA to capture edge effects within a historically disturbed environment, and 100 m downstream of the PDA within the high-water mark of the St. John River (Wolastoq), to be consistent with other relevant VCs. The LAA can be thought of as the theoretical “zone of influence” of the Project on vegetation and wetlands.

The LAA for a change in vegetation and wetlands is shown in Figure 7.1.



Stantec

- Black Raspberry, *Rubus occidentalis*
- Broad-Glumed Brome, *Bromus latiglumis*
- Butternut, *Juglans cinerea*
- Canada Wild Rye, *Elymus canadensis*
- Limestone Meadow Sedge, *Carex granularis*
- Project Development Area
- Local Assessment Area
- Road
- Transmission Line
- Watercourse (DNR)
- Wetland
- Kingsclear First Nation

0 100 200 metres
(At original document size of 8.5x11)
1:11,000

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan,

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-11-23

Client/Project
121415886_008
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
7.1

Title
Spatial Boundaries for Vegetation and Wetlands

V:\1214\active\121415886\gis\6_mapping\mxd\general\121415886_008_Veg_LAA.mxd Revised: 2022-11-23 By: mblackwood

7.2.4 Temporal Boundaries

The temporal boundaries for the assessment of the potential interactions between the project and vegetation and wetlands include the following periods:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

7.3 EXISTING CONDITIONS FOR VEGETATION AND WETLANDS

7.3.1 Methods

Vegetation and wetland surveys were conducted within the PDA and surrounding area in 2016. The spatial extent of these surveys included the potential footprint of other Project options that were under consideration at the time. During surveys, all vascular plant species were recorded on first observation. Any SAR or SOCC were recorded each time they were observed, and pertinent details such as population size were also recorded.

Wetlands were delineated following the procedures outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (U.S. Army Corps of Engineers 2012), which requires the presence of hydrophytic (*i.e.*, water-loving) vegetation, hydrology, and hydric soils to support a determination of wetland status.

7.3.2 Description of Existing Conditions

The Mactaquac Generating Station (MQGS) and surrounding area are within the Grand Lake Lowlands Ecoregion, one of seven ecoregions in New Brunswick that are primarily differentiated by climate, geology and soils, forest cover and vegetation, and wetlands (NBDNR 2007). The Grand Lake Lowlands Ecoregion, which also encompasses the Grand Lake Basin, the Oromocto River watershed, and the lower St. John River and its floodplains, has the warmest climate of any ecoregion in the province. Soils are dependent on regular flooding, and the ecoregion supports a unique assemblage of southern vegetation species that grow in the moist, rich soils (NBDNR 2007).

A review of provincial forestry and other land use data indicates that the area surrounding the MQGS contains a variety of habitat types, including:

- Hardwood stands
- Mixedwood stands
- Softwood stands, including plantations
- Shrub
- Agriculture
- Riparian mineral shore

- Wetlands
- Watercourses and waterbodies
- Developed land

Hardwood stands contain more than 70% broad-leaved trees in the tree canopy layer. Upstream of the MQGS, most hardwood stands are shade-intolerant hardwood stands dominated by poplar (*Populus* spp.). Downstream, other hardwoods can include oak (*Quercus* spp.), ash (*Fraxinus* spp.), white elm (*Ulmus americana*), basswood (*Tilia americana*), butternut (*Juglans cinerea*), or ironwood (*Ostrya virginiana*). Red maple (*Acer rubrum*) and birch (white and gray [*Betula papyrifera* and *B. populifolia*]) are also common species in hardwood stands, both upstream and downstream of the MQGS. Most hardwood stands upstream are mature and overmature. Most downstream stands are young and immature.

Mixedwood stands contain 30% to 70% hardwood and softwood species in the tree canopy layer and are not strongly dominated by either species group. Upstream of the MQGS, mixedwood stands are often dominated by poplar or birch; downstream, mixedwood stands are typically dominated by birch, red maple, or eastern hemlock (*Tsuga canadensis*). Stands dominated by eastern hemlock are also considered uncommon habitat types because this species, along with eastern white cedar (*Thuja occidentalis*), has declined since European settlement (Lutz 1997; Zelazny and Veen 1997). Mixedwood stands are mostly mature and immature upstream, and generally mature downstream of the MQGS.

Softwood stands contain more than 70% needle-leaved, cone-bearing trees in the tree canopy layer. Softwood stands upstream of the MQGS are dominated primarily by white spruce *(Picea glauca)*, balsam fir *(Abies balsamea),* and eastern white cedar. Downstream, softwood stands are dominated by eastern white pine *(Pinus strobus)* and white spruce, with lesser amounts of eastern white cedar and eastern hemlock. Many of the eastern white cedar stands have wet or poorly drained soils; they are likely forested wetlands. Softwood stands also include plantations, though these are relatively uncommon in the area surrounding the MQGS. Softwood stands are mostly mature and immature, both upstream and downstream of the MQGS.

Shrub stands are more common downstream than upstream of the MQGS. Most shrub communities in the area are dominated by speckled alder (*Alnus incana*). Many of these shrub stands are considered wet and may be unmapped wetlands. Other shrub habitats are dominated by other shrub or small tree species, such as various species of cherry (*Prunus* spp.), willow (*Salix* spp.), mountain or striped maple (*Acer spicatum* or *A. pensylvanicum*), or mountain ash (*Sorbus americana*).

Most agricultural land in the area around the MQGS is croplands and fallow pasture. Less commonly, agricultural land is used for cultivated blueberries, horticultural products, orchards, and Christmas tree farms.

Riparian mineral shore habitat includes areas along the margins of rivers or on islands that are periodically subjected to flooding and ice scour. This habitat type usually contains minimal to no woody vegetation (trees and shrubs), and individual patches are typically small in area. Because the water level near the MQGS is allowed to fluctuate up to approximately 1 m, some narrow bands of this habitat occur within Mactaquac Arm and other areas of the lower headpond, up to the Prince William area. This habitat is more common downstream, where natural watercourse disturbances occur. It occurs on many downstream islands and other floodplain areas.

Wetland habitats are more common downstream of the MQGS relative to upstream. The gentler slopes and terraces normally associated with river valley bottoms were covered when the headpond was created. Therefore, wetland area in this upstream section of the St. John River was reduced relative to historical amounts.

Developed land is typically unvegetated, aside from lawns and ornamental plants. In the vicinity of the MQGS, this land includes industrial land, infrastructure, recreational areas, and settled land.

The habitats within the LAA are generally not considered to have high ecological value due to their anthropogenic disturbance history or proximity to developed land. Most of the vegetated area within the LAA is regularly maintained lawn, with some other landscaped habitats. Unmaintained areas of the LAA are primarily composed of regenerating shrub species. One small area (approximately 0.5 hectares [ha]) of provincially inventoried forest exists near the northern extent of the LAA adjacent to Power House Lane. This forest stand is an immature hardwood stand, dominated by red maple, birches, and other hardwoods, with a small softwood component. These habitats are common within the surrounding area. The riparian mineral shore habitat present downstream of the MQGS is known to contain some rare plants but is outside of the LAA.

There are no provincially identified managed or sensitive areas relevant for vegetation or wetlands within the PDA or LAA, but several exist within the area surrounding the LAA. The Keswick Ridge Escarpment Environmentally Significant Area (ESA) is located approximately 1.5 km downstream of the MQGS, on the left (north) bank of the St. John River. This area includes riparian mineral shore and hardwood and mixedwood forest habitats on a steep slope and is thought to contain one of the richest concentrations of uncommon plant species in New Brunswick (Tims and Craig 1995). Other managed or sensitive areas that are not specifically relevant for vegetation or wetlands in the surrounding area include the Mactaquac River/Dam ESA, which was selected for the bird activity related to the dam and for the surrounding geology, and Mactaquac Provincial Park, which is located upstream of the MQGS on either side of the Mactaquac Arm.

AC CDC data returned for a 5-km radius around the MQGS included historical observations of four vascular plant SAR, one lichen SAR, and 49 vascular plant SOCC (Appendix 7.A) (AC CDC 2022b). The vascular plant and lichen SAR are listed in Table 7.1.

Table 7.1 Vascular Plant and Lichen SAR Known to Have Been Historically Observed Within 5 km of the MQGS (AC CDC 2022b)

Scientific Name	Common Name	SARA	COSEWIC	NB *SARA*	S Rank1
Juglans cinerea	Butternut	Endangered	Endangered	Endangered	S1
Pterospora andromedea	Woodland pinedrops	-[2]	-	Endangered	S1
Symphotrichum anticostense	Anticosti aster	Special concern	Special concern	Endangered	S3
Fraxinus nigra	Black ash	-	Threatened	-	S3S4
Anzia colpodes	Black-foam lichen	Threatened	Threatened	-	S1S2

Notes:
[1] S1 = Critically Imperiled, S2 = Imperiled, S3 = Vulnerable, S4 = Apparently Secure (AC CDC 2022a)
[2] - = No Status

During plant surveys conducted in 2016 in support of the Project, 323 vascular plant species were recorded. The list of plants has been updated to reflect recent changes in taxonomy and status rankings (Table 7A.1, Appendix 7.A). Two vascular plant SAR and seven vascular plant SOCC were observed in the area surrounding the PDA, but no rare species were observed directly within the PDA or LAA (Table 7.2, Figure 7.2). However, it is worth noting that black ash (*Fraxinus nigra*) was not a SAR when the field surveys were conducted, and each instance of this species may not have been recorded.

Table 7.2 Vascular Plant SAR and SOCC Observed During 2016 Vascular Plant Surveys

Scientific Name	Common Name	SARA	COSEWIC	NB *SARA*	S Rank[1]
Juglans cinerea	Butternut	Endangered	Endangered	Endangered	S1
Fraxinus nigra	Black ash	-	Threatened	-	S3S4
Bromus latiglumis	Broad-glumed brome	-	-	-	S3
Carex granularis	Limestone meadow sedge	-	-	-	S3
Carex rosea	Rosy sedge	-	-	-	S3
Elymus canadensis	Canada wild rye	-	-	-	S2S3
Fraxinus pennsylvanica	Red ash	-	-	-	S3
Rubus occidentalis	Black raspberry	-	-	-	S3
Verbena urticifolia	White vervain	-	-	-	S2S3

Notes:
[1] S1 = Critically Imperiled, S2 = Imperiled, S3 = Vulnerable, S4 = Apparently Secure (AC CDC 2022a)
[2] - = No Status

Several wetlands were delineated during field surveys conducted in support of the Project, in 2016. One of these is located within the PDA and another is located within the LAA (Figure 7.1). Wetland 1 is a graminoid-dominated marsh located near the centre of a large, regularly mowed lawn within the PDA on the MQGS property. This wetland is approximately 0.1 ha in size and has formed in a depression that collects overland flow and does not have any obvious hydrological connections to other wetlands or any watercourses or waterbodies. Wetland 2 was delineated near the base of the southern end of the earthen dam, in an area that is regularly submerged when water levels are high. This wetland, which is approximately 0.4 ha in size, is also a marsh and contained Canada wild rye (*Elymus canadensis*) and limestone meadow sedge (*Carex granularis*), two vascular plant SOCC both ranked S3. One of the Canada wild rye and both of the limestone meadow sedge observations are along the upland edge of this wetland, and a second Canada wild rye observation is near the river edge of the wetland. Canada wild rye was also observed along the banks of the St. John River downstream of the LAA.

7.4 EFFECTS ASSESSMENT

7.4.1 Assessment Criteria

7.4.1.1 Residual Effects Characterization

Table 7.3 presents definitions for the characterization of residual environmental effects on vegetation and wetlands. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not possible.

Table 7.3 Characterization of Residual Effects on Vegetation and Wetlands

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to vegetation and/or wetlands relative to baseline **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to vegetation and/or wetlands relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible –** no measurable change from baseline conditions **Low –** a measurable change of 5% or less of • habitat for or population of SAR or SOCC in the LAA • structure of vegetation communities and ESAs in the LAA • the total area of wetland types in the LAA, and/or below regulatory thresholds[1] **Moderate –** measurable change greater than 5% but not exceeding 25% of • habitat for or population of SAR or SOCC in the LAA • structure of vegetation communities and ESAs in the LAA • the total area of wetland types in the LAA **High –** measurable change of greater than 25% of • habitat for or population of SAR or SOCC in the LAA • structure of vegetation communities and ESAs in the LAA • the total area of wetland types in the LAA
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the PDA **LAA –** residual effects extend into the LAA

Table 7.3 Characterization of Residual Effects on Vegetation and Wetlands

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term** – residual effect extends for less than 1 year **Medium term** – residual effect extends through the construction phase (12 years) **Long term** – residual effect extends through the operation phase **Permanent –** recovery to baseline conditions unlikely
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not applicable –** effect does not occur during critical life stage or timing does not affect the VC **Applicable –** effect occurs during a critical life stage
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** – the residual effect occurs once **Irregular event** – the residual effect occurs at no set schedule **Regular event** – the residual effect occurs at regular intervals **Continuous –** the residual effect occurs continuously
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

Note:
[1] Alteration of wetlands larger than 1 ha or contiguous with a watercourse require a WAWA Permit under the *Watercourse and Wetland Alteration Regulation* of the *Clean Water Act.* Disturbance to 2 ha or more of wetland habitat is a trigger for a provincial EIA. Wetland regulatory thresholds are described in Section 7.2.1.2.

7.4.1.2 Significance Definition

A significant adverse residual effect on vegetation and wetlands is defined as one that, following the application of avoidance and mitigation measures:

- Results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA*, or in contravention of any of the prohibitions stated in Section 28 of NB *SARA*

- Threatens the long-term persistence or viability of a population of vascular plant SAR or SOCC such that long-term survival within the ecoregion is substantially reduced as a result, including effects that are contrary to or inconsistent with the goals, objectives, or activities of provincial or federal recovery strategies, action plans and management plans (*i.e.*, change from a non-listed species to a species of management concern)
- Threatens the long-term persistence or viability of a vegetation community in the ecoregion
- Results in an unauthorized net loss of wetland function after consideration of planned mitigation or provincially required compensation for unavoidable wetland loss

7.4.2 Potential Project Interactions with Vegetation and Wetlands

Activities and components of the Project could potentially interact with vegetation and wetlands to result in adverse environmental effects. In consideration of these potential interactions, the assessment of Project-related environmental effects on vegetation and wetlands is focused on the potential environmental effects listed in Table 7.4. These potential environmental effects will be assessed in consideration of specific measurable parameters, also listed in Table 7.4.

Table 7.4 Potential Environmental Effects and Measurable Parameters for Vegetation and Wetlands

Potential Environmental Effects	Effect Pathway	Measurable Parameters
Change in vascular plant SAR or SOCC	• Direct disturbance from site preparation activities, including clearing and grubbing • Siltation resulting from in -water works may damage plants within the downstream portion of the LAA	• Loss of vascular plant SAR or SOCC (individuals or populations)
Change in vegetation communities	• Direct disturbance from site preparation activities, including clearing and grubbing • Improper cleaning of equipment brought on site resulting in spread of invasive species • Siltation resulting from in -water works may damage plants within the downstream portion of the LAA	• Loss or change in structure of vegetation communities, in particular, special communities like ESAs or introduction or spread of invasive species
Change in wetland function	• Direct disturbance from site preparation activities, including clearing and grubbing can remove wetland area or remove woody vegetation, changing wetland type, both of which can lead to changes in wetland function • Siltation resulting from in -water works may damage plants within the downstream portion of the LAA, reducing wetland area or changing wetland type through a change in vegetation, leading to a change in wetland function	• Change in the area or type of wetlands, which relate to functions

Table 7.5 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 7.5 Potential Interactions Between Physical Activities and Vegetation and Wetlands

Physical Activities	Change in Vascular Plant SAR and SOCC	Change in Vegetation Communities	Change in Wetland Function
Construction			
Site preparation	✓	✓	✓
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	✓	✓	✓
Isolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	-	-	-
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	-	-	-
Shut down of power units	-	-	-
Fish passage	-	-	-
Transportation (*powerhouse: transportation of equipment)*	-	-	-
Employment and expenditure	-	-	-
Operation and Maintenance			
Operation of the MQGS	-	-	-
Maintenance of the MQGS	-	-	-
Fish passage	-	-	-
Notes: ✓ = Potential interaction – = No interaction			

The majority of potential effects to vegetation and wetlands as a result of Project activities will occur during the construction phase, specifically during site preparation activities and some limited interactions with downstream vegetation communities arising from in-water works. Many planned Project activities and physical works will be limited in their footprint to existing infrastructure and adjacent and other non-naturalized areas and are therefore not expected to interact with vegetation and wetlands, including isolated work in the dry, work above the water line, shut down of power units, fish passage during construction and operation and maintenance, transportation, operation of the facility, and maintenance of the facility. Changes in employment and expenditure are not expected to interact with vegetation and wetlands. There are no known interactions with vegetation and wetlands during the operation and maintenance phase since effects with vegetation and wetlands will occur during construction and no further disturbance of land is expected during operation and maintenance that did not already occur during the construction phase.

7.4.2.1 Potential Effects on Vegetation and Wetlands During Construction

Change in Vascular Plant SAR and SOCC

There were no vascular plant SAR or SOCC observed within the PDA during field surveys; however, several SOCC vascular plants were observed within the LAA. These plants were observed within a wetland located within the St. John River, adjacent to the MQGS earthen dam. This wetland is regularly flooded when water levels downstream of the MQGS fluctuate.

Equipment used for site preparation activities can introduce invasive plant species to wetland and aquatic environments within the PDA and LAA. Invasive species can outcompete native vegetation, including SOCC.

Site preparation activities requiring heavy equipment in or near the water can alter water quality associated with soil or substrate disturbance. Suspended solids can settle on top of these periodically submerged plants.

In-water work may also alter downstream water quality through soil or substrate disturbance. During in-water work, the release of untreated water from areas requiring dewatering into the aquatic environment can affect shoreline vegetation, including SOCC, if suspended sediments and/or contaminants are released.

Change in Vegetation Communities

Site preparation will include vegetation clearing, which can result in the direct loss of vegetation communities. Clearing will remove trees and shrubs and damage many other plants, and grubbing will completely remove vegetation from the Project footprint, where it occurs. Habitats adjacent to cleared areas can be affected by edge effects resulting from changes in abiotic factors, including light availability, humidity, temperature, and wind. Changes to these abiotic factors can alter the ability of species to continue to grow in affected areas and can make habitats more suitable for invasive species.

Equipment used for site preparation activities can introduce invasive plant species to upland, wetland, and aquatic environments within the PDA and LAA. Invasive species can outcompete native vegetation and alter vegetation communities.

Site preparation activities requiring heavy equipment in or near the water can alter vegetation communities downstream of the PDA through alteration of water quality associated with soil or substrate disturbance. Suspended solids can settle on top of aquatic or periodically submerged vegetation.

In-water work may also alter the water quality of downstream vegetation communities through soil or substrate disturbance. During in-water work, the release of untreated water from areas requiring dewatering into the aquatic environment can affect shoreline vegetation communities if suspended sediments and/or contaminants are released.

Change in Wetland Function

Direct loss of wetland habitat and functions could occur for wetland area located within the PDA. This loss could occur through vegetation clearing and grubbing, and infilling

Habitats adjacent to cleared areas can be indirectly affected by edge effects resulting from changes in abiotic factors, including light availability, humidity, temperature, and wind, which could change soil water levels, altering wetland area. Site preparation can lead to indirect changes to adjacent wetlands (either in the PDA or LAA) through alterations in hydrology, which could result in a raise or lowering of water levels in adjacent wetlands.

Equipment used for site preparation activities can introduce invasive plant species to wetlands within the PDA and LAA. Invasive species can outcompete native vegetation and alter vegetation communities, including wetlands.

Site preparation activities requiring heavy equipment in or near the water could alter wetlands downstream of the PDA through alteration of water quality associated with soil or substrate disturbance. Suspended solids could settle on top of aquatic or periodically submerged vegetation.

In-water work may also alter the water quality of downstream habitats, including wetlands, through soil or substrate disturbance. During in-water work, the release of untreated water from areas requiring dewatering into the aquatic environment could affect wetlands within aquatic and shoreline habitats if suspended sediments and/or contaminants are released.

7.4.2.2 Potential Effects on Vegetation and Wetlands During Operation and Maintenance

None of the activities or physical works expected to occur during operation and maintenance of the Project are considered likely to interact with the vegetation and wetlands, as operation of the MQGS is planned to continue largely as it does currently, and water levels in the headpond and downstream area are expected to remain consistent with pre-Project levels. Project interactions with vegetation and wetlands during operation and maintenance are therefore not discussed further.

7.4.3 Mitigation for Vegetation and Wetlands

Interactions between Project activities and the vegetation and wetlands will be managed using various mitigation measures. The following mitigation measures specific to vegetation and wetlands have been identified for this Project.

- Clearing and grubbing will be confined to the PDA footprint.
- Grading will be reduced in native vegetation communities.
- Known locations of vascular plant SAR and SOCC within 30 m of the PDA will be flagged and avoided, if feasible.
- Equipment will be inspected prior to arrival at the site to see that it is clean and free of soil or vegetative debris. Equipment which arrives in a dirty condition will not be allowed on the site until it has been cleaned.

- Vehicles and equipment will be operated within previously disturbed areas, wherever reasonably possible.
- The size of temporary workspaces will be limited to the extent reasonably possible.
- The placement of temporary workspaces will avoid wetlands and mature forested habitat to the extent feasible.
- Material stockpiles will be kept a minimum of 30 m from a watercourse or waterbody with the appropriate erosion control mitigation in place to prevent sediment from entering a watercourse or waterbody.
- A Project-specific Environmental Management Plan (PSEMP) that includes a site-wide sedimentation and erosion protection plan will be implemented for the Project.
- Natural regeneration of disturbed areas will be allowed when the risk of erosion is deemed low.
  - If erosion risk in particular areas is deemed to be high and reseeding is considered warranted, the vegetation in the undisturbed surrounding area will be considered prior to selecting an appropriate seed mix for the site.
- Temporarily disturbed areas will be restored to pre-construction conditions.

7.4.4 Characterization for Residual Project Environmental Interactions for Vegetation and Wetlands

7.4.4.1 Residual Effects on Vegetation and Wetlands During Construction

Change in Vascular Plant SAR and SOCC

The Project is not expected to lead to the direct loss of vascular plant SAR and SOCC during construction as there were no vascular plant SAR or SOCC observed within the PDA during field surveys. However, some limited indirect effects may result as two vascular plant species were observed in the LAA. Potential pathways for interactions with vascular plant SAR and SOCC are related solely to indirect disturbance resulting from site preparation and in-water work activities planned within the adjacent PDA. The observed SOCC within the LAA are located on the landward side of a wetland adjacent to the earthen dam. These plants are accustomed to periodic flooding and likely experience some disturbance and sedimentation when ice scour occurs, or during times when water flows are turbulent, *e.g.*, during the spring freshet. Development of the Project during construction is expected to be adverse in direction and low in magnitude as it will not result in a measurable change of more than 5% of habitat for, or population of SAR or SOCC in the LAA. The geographic extent is expected to be restricted to the LAA with the inclusion of some possible downstream sedimentation. The duration is expected to be long term as there is a permanent footprint for many Project components that will be maintained for the life of the Project. Timing is considered not applicable for vascular plant SAR and SOCC. The frequency of interactions is expected to be a single event, and the interaction is expected to be reversible for vascular plant SAR and SOCC, with rehabilitation, where warranted. The interactions will occur within a disturbed ecological and socioeconomic context.

Change in Vegetation Communities

The vegetation communities that exist outside of the industrial portions of the PDA and LAA are largely anthropogenic, including regularly maintained lawns and landscaped habitats, with some regenerating habitat dominated by shrubs and young trees, a small portion (< 0.5 ha) of an immature hardwood stand, and portions of two small freshwater marsh wetlands. In some areas within the LAA, vegetation is regenerating within previously disturbed or infilled areas. There are no vegetation or wetland-related ESAs within the LAA.

Potential pathways for interactions with vegetation communities are mostly related to direct disturbance resulting from site preparation activities planned within the PDA. Vegetation communities within the planned PDA are largely anthropogenic, *i.e.*, areas that are maintained as lawns or within the existing industrial footprint associated with the current MQGS, with a small amount of the PDA within natural areas adjacent to anthropogenic habitats that would currently experience edge effects. Development of the Project during construction is expected to be adverse in direction and low in magnitude as it will not result in a measurable change of more than 5% of the structure of vegetation communities and ESAs in the LAA. The geographic extent is expected to be restricted to the LAA with the inclusion of possible edge effects. The duration is expected to be long term as there is a permanent footprint for many Project components that will be maintained for the life of the Project. Timing is considered not applicable for vegetation communities and ESAs. The frequency of interactions is expected to be a single event, and the interaction is expected to be reversible for vegetation communities and ESAs, with rehabilitation, where warranted. The interactions will occur within a disturbed ecological and socioeconomic context.

Change in Wetland Function

The Project may lead to the direct loss of wetland habitat or function during construction as Wetland 1 is located within the PDA, though this wetland may be avoided. Additionally, some limited indirect effects may result within Wetland 2 as it is within 30 m of the PDA near the earthen dam (Figure 7.1).

Potential pathways for interactions with wetland area or type may occur through either direct or indirect disturbance resulting from site preparation and in-water work activities planned within the PDA. The wetland within the PDA is anthropogenic (*i.e.,* the wetland within a mowed lawn, north of the MQGS), and the wetland within the LAA is within a natural area adjacent to anthropogenic habitats (*i.e.*, the wetland adjacent to the earthen portion of the dam).

The direct and indirect interaction with wetlands will be adverse in direction and low in magnitude, as the changes to wetlands will be below regulatory thresholds (*i.e.*, no alteration of wetlands greater than 1 ha in size or contiguous with a watercourse is expected, Section 7.2.1.2). The geographic extent is expected to be limited to the LAA as some indirect disturbance may result in changes to the wetland beyond the PDA. The duration of change is expected to be long term as no compensation will be required since the predicted changes to wetlands are below regulatory thresholds. Timing is considered not applicable for wetlands. The frequency of interactions is expected to be a single event, and the interaction is expected to be reversible for wetlands, with rehabilitation. The interactions will occur within a disturbed ecological and socioeconomic context.

7.4.4.2 Summary

A summary of the residual environmental effects characterization (Table 7.3), following the application of mitigation measures described in Section 7.4.3, on vegetation and wetlands during the construction phase of the Project is provided in Table 7.6. No residual effects on vascular plant SAR or SOCC are anticipated, as no vascular plant SAR or SOCC were observed within the LAA. No residual effects on vegetation and wetlands are anticipated during the operation and maintenance phase of the Project.

Table 7.6 Project Residual Effects on Vegetation and Wetlands

Residual Effect	Residual Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Vascular Plant SAR or SOCC	C	A	L	LAA	LT	N/A	S	R	D
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Change in Vegetation Communities	C	A	L	LAA	LT	NA	S	R	D
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Change in Wetland Function	C	A	L	LAA	LT	NA	S	R	D
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

KEY
See Table 7.3 for detailed definitions

Project Phase
C: Construction
O: Operation and maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not Applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological / Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

7.5 DETERMINATION OF SIGNIFICANCE

No vascular plant SAR or SOCC were recorded within the PDA. Vascular plant SOCC that were recorded in the LAA may experience limited indirect effects. Habitats within the PDA that may be disturbed by the Project are largely anthropogenic or regenerating, and within a disturbed, industrial area. Wetlands within the PDA and LAA that are <1 ha in size may experience either direct or limited indirect effects.

With the implementation of mitigation and environmental protection measures as described in this assessment, it is anticipated that the residual adverse environmental effects of the Project on vegetation and wetlands will be not significant. Following mitigation, the Project will not result in a non-permitted contravention of relevant prohibitions in *SARA* or NB *SARA*; will not threaten the long-term persistence or viability of vascular plant SAR or SOCC such that their long-term survival within the ecoregion is substantially reduced; will not threaten the long-term persistence of viability of a vegetation community in the ecoregion; and will not result in an unauthorized net loss of wetland function. In conclusion, the residual environmental effects of the Project on vegetation and wetlands during all phases of the Project are rated not significant, with a high level of confidence.

7.6 FOLLOW UP AND MONITORING

A dedicated follow-up and monitoring plan is not required for vegetation and wetlands to verify the environmental effects predictions of the assessment or to verify the effectiveness of mitigation.

7.7 REFERENCES

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APPENDIX 7.A

AC CDC REPORT

Atlantic Canada Conservation Data Centre
Centre de données sur la conservation du Canada atlantique

DATA REPORT 7404: Mactaquac, NB

Prepared 19 August 2022
by C. Robicheau, Conservation Data Analyst

CONTENTS OF REPORT

Map 1. A 100 km buffer around the study area

1.0 PREFACE

The Atlantic Canada Conservation Data Centre (AC CDC; www.accdc.com) is part of a network of NatureServe data centres and heritage programs serving 50 states in the U.S.A, 10 provinces and 1 territory in Canada, plus several Central and South American countries. The NatureServe network is more than 30 years old and shares a common conservation data methodology. The AC CDC was founded in 1997, and maintains data for the jurisdictions of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Although a non-governmental agency, the AC CDC is supported by 6 federal agencies and 4 provincial governments, as well as through outside grants and data processing fees.

Upon request and for a fee, the AC CDC queries its database and produces customized reports of the rare and endangered flora and fauna known to occur in or near a specified study area. As a supplement to that data, the AC CDC includes locations of managed areas with some level of protection, and known sites of ecological interest or sensitivity.

1.1 DATA LIST

Included datasets:

Filename	**Contents**
MactaquacNB_7404ob.xls	Rare or legally-protected Flora and Fauna in your study area
MactaquacNB_7404ob100km.xls	A list of Rare and legally protected Flora and Fauna within 100 km of your study area
MactaquacNB_7404msa.xls	Managed and Biologically Significant Areas in your study area
MactaquacNB_7404ff_py.xls	Rare Freshwater Fish in your study area (DFO database)

1.2 RESTRICTIONS

The AC CDC makes a strong effort to verify the accuracy of all the data that it manages, but it shall not be held responsible for any inaccuracies in data that it provides. By accepting AC CDC data, recipients assent to the following limits of use:

a) Data is restricted to use by trained personnel who are sensitive to landowner interests and to potential threats to rare and/or endangered flora and fauna posed by the information provided.
b) Data is restricted to use by the specified Data User; any third party requiring data must make its own data request.
c) The AC CDC requires Data Users to cease using and delete data 12 months after receipt, and to make a new request for updated data if necessary at that time.
d) AC CDC data responses are restricted to the data in our Data System at the time of the data request.
e) Each record has an estimate of locational uncertainty, which must be referenced in order to understand the record's relevance to a particular location. Please see attached Data Dictionary for details.
f) AC CDC data responses are not to be construed as exhaustive inventories of taxa in an area.
g) The absence of a taxon cannot be inferred by its absence in an AC CDC data response.

1.3 ADDITIONAL INFORMATION

The accompanying Data Dictionary provides metadata for the data provided.

Please direct any additional questions about AC CDC data to the following individuals:

Plants, Lichens, Ranking Methods, All other Inquiries	Sean Blaney	Senior Scientist / Executive Director	(506) 364-2658	sean.blaney@accdc.ca
Animals (Fauna)	John Klymko	Zoologist	(506) 364-2660	john.klymko@accdc.ca
Data Management, GIS	James Churchill	Conservation Data Analyst / Field Biologist		james.churchill@accdc.ca
Billing	Jean Breau	Financial Manager / Executive Assistant	(506) 364-2657	jean.breau@accdc.ca

Questions on the biology of Federal Species at Risk can be directed to AC CDC: (506) 364-2658, with questions on Species at Risk regulations to: Samara Eaton, Canadian Wildlife Service (NB and PE): (506) 364-5060 or Julie McKnight, Canadian Wildlife Service (NS): (902) 426-4196.

New Brunswick. For information about rare taxa, protected areas, game animals, deer yards, old growth forests, archeological sites, fish habitat etc., or to determine if location-sensitive species (section 4.3) occur near your study site, please contact Hubert Askanas, Energy and Resource Development: (506) 453-5873.

Nova Scotia. For information about Species at Risk or general questions about Nova Scotia location-sensitive species please contact the Biodiversity Program at biodiversity@novascotia.ca. For questions about protected areas, game animals, deer yards, old growth forests, archeological sites, fish habitat etc., or to determine if location-sensitive species (section 4.3) occur near your study site please contact a Regional Biologist:

DIGB, ANNA, KING	Emma Vost	(902) 670-8187	Emma.Vost@novascotia.ca
SHEL, YARM	Sian Wilson	(902) 930-2978	Sian.Wilson@novascotia.ca
QUEE, LUNE	Peter Kydd	(902) 523-0969	Peter.Kydd@novascotia.ca
HALI, HANT	Shavonne Meyer	(902) 893-0816	Shavonne.Meyer@novascotia.ca
Central Region	Jolene Laverty	(902) 324-8953	Jolene.Laverty@novascotia.ca
COLC, CUMB	Kimberly George	(902) 890-1046	Kimberly.George@novascotia.ca
ANTI, GUYS	Harrison Moore	(902) 497-4119	Harrison.Moore@novascotia.ca
INVE, VICT	Maureen Cameron-MacMillan	(902) 295-2554	Maureen.Cameron-MacMillan@novascotia.ca
CAPE, RICH, PICT	Elizabeth Walsh	(902) 563-3370	Elizabeth.Walsh@novascotia.ca

Prince Edward Island. For information about rare taxa, protected areas, game animals, fish habitat etc., please contact Garry Gregory, PEI Department of Environment, Energy and Climate Action: (902) 569-7595.

2.0 RARE AND ENDANGERED SPECIES

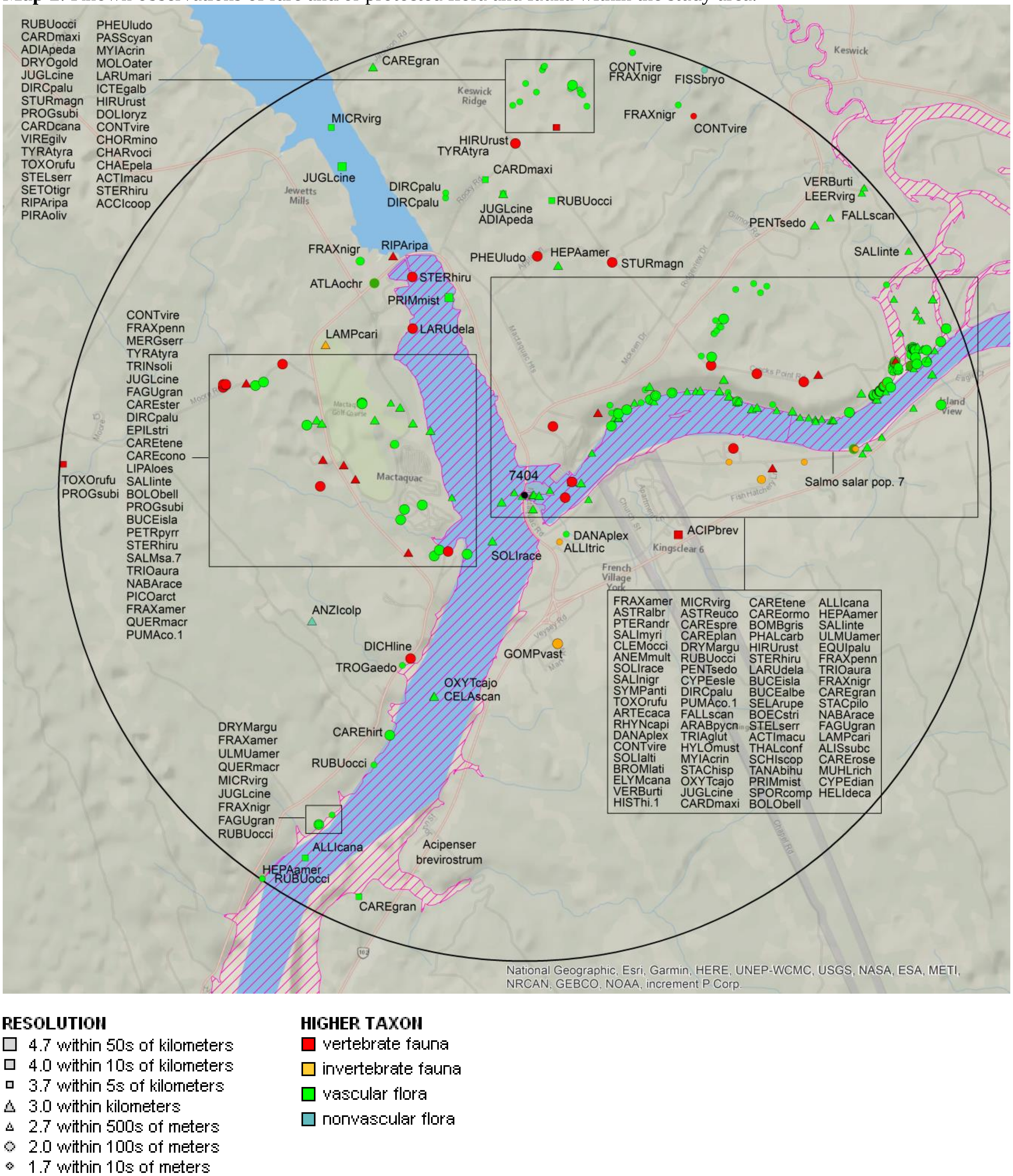
2.1 FLORA

The study area contains 340 records of 69 vascular and 2 records of 2 nonvascular flora (Map 2 and attached: *ob.xls).

2.2 FAUNA

The study area contains 106 records of 39 vertebrate and 20 records of 6 invertebrate fauna (Map 2 and attached data files - see 1.1 Data List). Please see section 4.3 to determine if 'location-sensitive' species occur near your study site.

Map 2: Known observations of rare and/or protected flora and fauna within the study area.

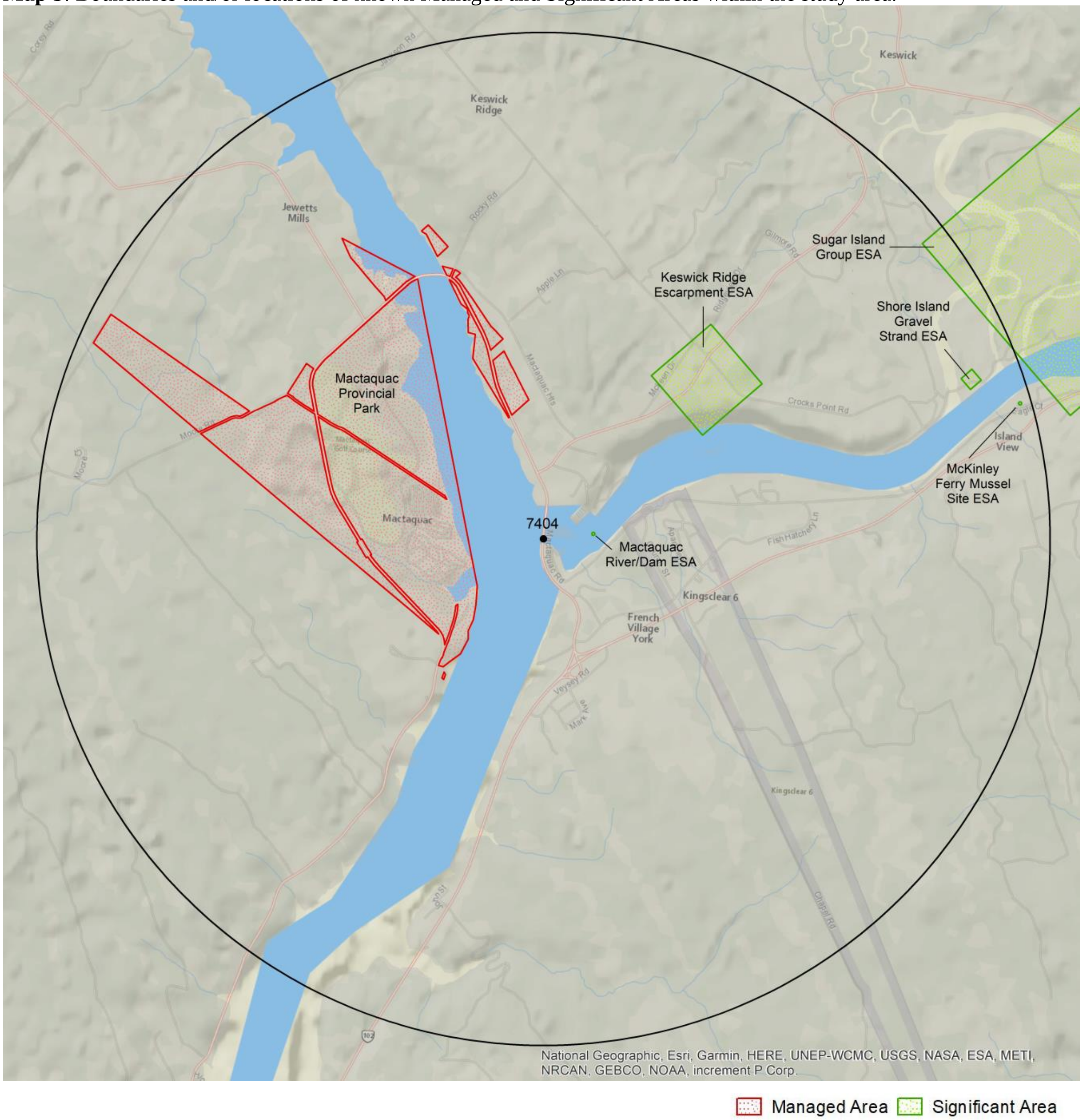


3.0 SPECIAL AREAS

3.1 MANAGED AREAS
The GIS scan identified 1 managed area in the vicinity of the study area (Map 3 and attached file: *ma*.xls).

3.2 SIGNIFICANT AREAS
The GIS scan identified 5 biologically significant sites in the vicinity of the study area (Map 3 and attached file: *sa*.xls).

Map 3: Boundaries and/or locations of known Managed and Significant Areas within the study area.



4.0 RARE SPECIES LISTS

Rare and/or endangered taxa (excluding "location-sensitive" species, section 4.3) within the study area listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record). [P] = vascular plant, [N] = nonvascular plant, [A] = vertebrate animal, [I] = invertebrate animal, [C] = community. Note: records are from attached files *ob.xls/*ob.shp only.

4.1 FLORA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened		S1S2	1	2.6 ± 1.0
N	*Fissidens bryoides*	Lesser Pocket Moss				S3S4	1	5.0 ± 0.0
P	*Juglans cinerea*	Butternut	Endangered	Endangered	Endangered	S1	27	1.3 ± 0.0
P	*Fraxinus nigra*	Black Ash	Threatened			S3S4	8	2.5 ± 1.0
P	*Symphyotrichum anticostense*	Anticosti Aster	Special Concern	Special Concern	Endangered	S3	4	1.7 ± 0.0
P	*Pterospora andromedea*	Woodland Pinedrops			Endangered	S1	5	1.5 ± 0.0
P	*Helianthus decapetalus*	Ten-rayed Sunflower				S1	7	3.8 ± 1.0
P	*Carex sterilis*	Sterile Sedge				S1	1	1.7 ± 0.0
P	*Cyperus diandrus*	Low Flatsedge				S1	2	4.4 ± 0.0
P	*Rhynchospora capillacea*	Slender Beakrush				S1	3	2.5 ± 0.0
P	*Allium canadense*	Canada Garlic				S1	10	1.7 ± 0.0
P	*Sporobolus compositus*	Rough Dropseed				S1	16	0.0 ± 0.0
P	*Selaginella rupestris*	Rock Spikemoss				S1	7	0.3 ± 0.0
P	*Alisma subcordatum*	Southern Water Plantain				S1?	1	3.4 ± 0.0
P	*Astragalus eucosmus*	Elegant Milk-vetch				S2	6	1.8 ± 0.0
P	*Quercus macrocarpa*	Bur Oak				S2	4	1.2 ± 0.0
P	*Micranthes virginiensis*	Early Saxifrage				S2	13	0.6 ± 1.0
P	*Hepatica americana*	Round-lobed Hepatica				S2S3	9	1.8 ± 1.0
P	*Dirca palustris*	Eastern Leatherwood				S2S3	6	1.6 ± 1.0
P	*Verbena urticifolia*	White Vervain				S2S3	7	4.0 ± 0.0
P	*Allium tricoccum*	Wild Leek				S2S3	1	0.6 ± 0.0
P	*Elymus canadensis*	Canada Wild Rye				S2S3	8	0.2 ± 1.0
P	*Artemisia campestris ssp. caudata*	Tall Wormwood				S3	5	4.4 ± 0.0
P	*Nabalus racemosus*	Glaucous Rattlesnakeroot				S3	3	0.8 ± 0.0
P	*Solidago racemosa*	Racemose Goldenrod				S3	10	0.6 ± 1.0
P	*Tanacetum bipinnatum ssp. huronense*	Lake Huron Tansy				S3	7	0.2 ± 1.0
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S3	4	1.3 ± 1.0
P	*Cardamine maxima*	Large Toothwort				S3	4	2.5 ± 0.0
P	*Boechera stricta*	Drummond's Rockcress				S3	4	0.1 ± 0.0
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	5	0.9 ± 0.0
P	*Astragalus alpinus var. brunetianus*	Alpine Milk-Vetch				S3	1	4.9 ± 1.0
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S3	6	2.4 ± 1.0
P	*Fraxinus pennsylvanica*	Red Ash				S3	8	2.5 ± 0.0
P	*Primula mistassinica*	Mistassini Primrose				S3	2	0.1 ± 1.0
P	*Anemone multifida*	Cut-leaved Anemone				S3	1	0.9 ± 0.0
P	*Clematis occidentalis*	Purple Clematis				S3	2	3.0 ± 1.0
P	*Rubus occidentalis*	Black Raspberry				S3	13	1.3 ± 0.0
P	*Salix myricoides*	Bayberry Willow				S3	4	4.4 ± 0.0
P	*Salix nigra*	Black Willow				S3	1	4.6 ± 1.0
P	*Salix interior*	Sandbar Willow				S3	12	1.2 ± 1.0
P	*Carex conoidea*	Field Sedge				S3	1	2.3 ± 1.0
P	*Carex granularis*	Limestone Meadow Sedge				S3	5	1.3 ± 0.0
P	*Carex hirtifolia*	Pubescent Sedge				S3	1	3.0 ± 0.0
P	*Carex ormostachya*	Necklace Spike Sedge				S3	1	2.5 ± 1.0
P	*Carex plantaginea*	Plantain-Leaved Sedge				S3	1	2.8 ± 0.0

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
P	*Carex rosea*	Rosy Sedge				S3	1	1.3 ± 0.0
P	*Carex sprengelii*	Longbeak Sedge				S3	1	3.2 ± 0.0
P	*Cyperus esculentus var. leptostachyus*	Perennial Yellow Nutsedge				S3	3	3.9 ± 0.0
P	*Bromus latiglumis*	Broad-Glumed Brome				S3	1	1.6 ± 0.0
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	1	2.2 ± 0.0
P	*Leersia virginica*	White Cut Grass				S3	5	4.9 ± 0.0
P	*Muhlenbergia richardsonis*	Mat Muhly				S3	9	1.8 ± 0.0
P	*Schizachyrium scoparium*	Little Bluestem				S3	8	0.1 ± 1.0
P	*Adiantum pedatum*	Northern Maidenhair Fern				S3	8	3.2 ± 5.0
P	*Dryopteris goldieana*	Goldie's Woodfern				S3	1	4.4 ± 0.0
P	*Solidago altissima*	Tall Goldenrod				S3S4	1	4.4 ± 0.0
P	*Penthorum sedoides*	Ditch Stonecrop				S3S4	2	4.2 ± 0.0
P	*Fagus grandifolia*	American Beech				S3S4	5	1.1 ± 0.0
P	*Stachys hispida*	Smooth Hedge-Nettle				S3S4	5	1.2 ± 0.0
P	*Stachys pilosa*	Hairy Hedge-Nettle				S3S4	1	4.4 ± 0.0
P	*Fraxinus americana*	White Ash				S3S4	7	1.1 ± 0.0
P	*Epilobium strictum*	Downy Willowherb				S3S4	4	2.4 ± 1.0
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	3	3.7 ± 1.0
P	*Thalictrum confine*	Northern Meadow-rue				S3S4	2	0.3 ± 1.0
P	*Drymocallis arguta*	Tall Wood Beauty				S3S4	9	1.3 ± 1.0
P	*Ulmus americana*	White Elm				S3S4	7	2.5 ± 1.0
P	*Carex tenera*	Tender Sedge				S3S4	3	1.8 ± 1.0
P	*Triantha glutinosa*	Sticky False-Asphodel				S3S4	4	2.4 ± 1.0
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	1	1.4 ± 1.0
P	*Equisetum palustre*	Marsh Horsetail				S3S4	1	4.6 ± 0.0
P	*Celastrus scandens*	Climbing Bittersweet				SX	1	2.4 ± 1.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Salmo salar pop. 7*	Atlantic Salmon - Outer Bay of Fundy population	Endangered		Endangered	SNR	1	1.0 ± 0.0
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened	Threatened	S1B	2	2.7 ± 0.0
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened	Threatened	S1S2B	1	3.4 ± 1.0
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened		S2B	3	2.9 ± 1.0
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	1	4.0 ± 7.0
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern population	Special Concern	Special Concern	Endangered	S1B,S1S2N,S2M	1	4.2 ± 0.0
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Threatened	S2B	7	0.5 ± 0.0
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern	Special Concern	S2S3N,S3M	7	0.5 ± 0.0
A	*Acipenser brevirostrum*	Shortnose Sturgeon	Special Concern	Special Concern	Special Concern	S3	1	1.7 ± 10.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S3B	10	2.4 ± 0.0
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Threatened	S3B	3	4.0 ± 7.0
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Threatened	Threatened	S3B,S4M	1	4.0 ± 7.0
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Threatened	S3S4B	1	4.0 ± 7.0
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1S2B	1	4.0 ± 7.0
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B,SUM	9	0.5 ± 0.0
A	*Puma concolor pop. 1*	Cougar - Eastern population	Data Deficient		Endangered	SU	2	1.2 ± 1.0
A	*Progne subis*	Purple Martin				S1B	3	2.0 ± 1.0
A	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow				S1S2B	2	0.4 ± 0.0
A	*Troglodytes aedon*	House Wren				S1S2B	3	2.1 ± 0.0
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2B	1	1.8 ± 2.0
A	*Tringa solitaria*	Solitary Sandpiper				S2B,S4S5M	1	3.4 ± 0.0
A	*Phalacrocorax carbo*	Great Cormorant				S2N	1	0.5 ± 0.0
A	*Toxostoma rufum*	Brown Thrasher				S2S3B	4	0.5 ± 0.0

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Icterus galbula*	Baltimore Oriole				S2S3B	2	4.0 ± 7.0
A	*Larus delawarensis*	Ring-billed Gull				S2S3B,S4N,S5M	5	0.5 ± 0.0
A	*Larus marinus*	Great Black-backed Gull				S3	3	4.0 ± 7.0
A	*Picoides arcticus*	Black-backed Woodpecker				S3	1	2.2 ± 0.0
A	*Charadrius vociferus*	Killdeer				S3B	2	4.0 ± 7.0
A	*Myiarchus crinitus*	Great Crested Flycatcher				S3B	3	2.8 ± 0.0
A	*Piranga olivacea*	Scarlet Tanager				S3B	1	4.0 ± 7.0
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	5	2.6 ± 0.0
A	*Passerina cyanea*	Indigo Bunting				S3B	1	4.0 ± 7.0
A	*Molothrus ater*	Brown-headed Cowbird				S3B	1	4.0 ± 7.0
A	*Setophaga tigrina*	Cape May Warbler				S3B,S4S5M	1	4.0 ± 7.0
A	*Mergus serrator*	Red-breasted Merganser				S3B,S4S5N,S5M	1	3.2 ± 1.0
A	*Bucephala albeola*	Bufflehead				S3N	2	0.5 ± 0.0
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B	7	3.4 ± 0.0
A	*Vireo gilvus*	Warbling Vireo				S3S4B	1	4.0 ± 7.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S4M	4	0.5 ± 0.0
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Special Concern	S2S3?B	11	0.6 ± 0.0
I	*Lampsilis cariosa*	Yellow Lampmussel	Special Concern	Special Concern	Special Concern	S3	3	2.7 ± 1.0
I	*Boloria bellona*	Meadow Fritillary				S3	2	1.5 ± 0.0
I	*Gomphurus vastus*	Cobra Clubtail				S3	1	1.6 ± 0.0
I	*Atlanticoncha ochracea*	Tidewater Mucket				S3	2	2.8 ± 0.0
I	*Bombus griseocollis*	Brown-belted Bumble Bee				S3S4	1	4.1 ± 0.0

4.3 LOCATION SENSITIVE SPECIES

The Department of Natural Resources in each Maritimes province considers a number of species "location sensitive". Concern about exploitation of location-sensitive species precludes inclusion of precise coordinates in this report. Those intersecting your study area are indicated below with "YES".

New Brunswick

Scientific *Name*	Common Name	SARA	Prov Legal Prot	Known within the Study Site?
Chrysemys picta picta	Eastern Painted Turtle	Special Concern		No
Chelydra serpentina	**Snapping Turtle**	**Special Concern**	**Special Concern**	**YES**
Glyptemys insculpta	Wood Turtle	Threatened	Threatened	No
Haliaeetus leucocephalus	**Bald Eagle**		**Endangered**	**YES**
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.	Special Concern	Endangered	No
Cicindela marginipennis	Cobblestone Tiger Beetle	Endangered	Endangered	No
Coenonympha nipisiquit	Maritime Ringlet	Endangered	Endangered	No
Bat hibernaculum or bat species occurrence		**[Endangered][1]**	**[Endangered][1]**	**YES**

1 *Myotis lucifugus* (Little Brown Myotis), *Myotis septentrionalis* (Long-eared Myotis), and *Perimyotis subflavus* (Tri-colored Bat or Eastern Pipistrelle) are all Endangered under the Federal Species at Risk Act and the NB Species at Risk Act.

4.4 SOURCE BIBLIOGRAPHY

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
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5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 27226 records of 159 vertebrate and 1717 records of 74 invertebrate fauna; 14774 records of 361 vascular and 1063 records of 170 nonvascular flora (attached: *ob100km.xls).

Taxa within 100 km of the study site that are rare and/or endangered in the province in which the study site occurs (including “location-sensitive” species). All ranks correspond to the province in which the study site falls, even for out-of-province records. Taxa are listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record).

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	62	17.2 ± 1.0	NB
A	*Myotis septentrionalis*	Northern Myotis	Endangered	Endangered	Endangered	S1	15	17.2 ± 1.0	NB
A	*Perimyotis subflavus*	Tricolored Bat	Endangered	Endangered	Endangered	S1	3	94.6 ± 0.0	NB
A	*Osmerus mordax pop. 2*	Rainbow Smelt - Lake Utopia Large-bodied population	Endangered	Threatened	Threatened	S1	2	86.4 ± 10.0	NB
A	*Charadrius melodus melodus*	Piping Plover melodus subspecies	Endangered	Endangered	Endangered	S1B	5	99.0 ± 0.0	NB
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1B	2	97.7 ± 5.0	NB
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay	Endangered	Endangered	Endangered	S2	437	24.9 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
		of Fundy population							
A	*Melanerpes erythrocephalus*	Red-headed Woodpecker	Endangered	Threatened		SNA	1	68.9 ± 7.0	NB
A	*Empidonax virescens*	Acadian Flycatcher	Endangered	Endangered		SNA	2	15.2 ± 0.0	NB
A	*Protonotaria citrea*	Prothonotary Warbler	Endangered	Endangered		SNA	1	99.5 ± 2.0	NB
A	*Icteria virens*	Yellow-Breasted Chat	Endangered	Endangered		SNA	4	69.0 ± 7.0	NB
A	*Salmo salar pop. 7*	Atlantic Salmon - Outer Bay of Fundy population	Endangered		Endangered	SNR	44	1.0 ± 0.0	NB
A	*Rangifer tarandus pop. 2*	Caribou - Atlantic-Gasp├⌐sie population	Endangered	Endangered	Extirpated	SX	4	45.8 ± 1.0	NB
A	*Colinus virginianus*	Northern Bobwhite	Endangered	Endangered			4	74.2 ± 0.0	NB
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened	Threatened	S1B	44	2.7 ± 0.0	NB
A	*Asio flammeus*	Short-eared Owl	Threatened	Special Concern	Special Concern	S1S2B	15	53.0 ± 0.0	NB
A	*Ixobrychus exilis*	Least Bittern	Threatened	Threatened	Threatened	S1S2B	31	10.8 ± 7.0	NB
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened	Threatened	S1S2B	234	3.4 ± 1.0	NB
A	*Hydrobates leucorhous*	Leach's Storm-Petrel	Threatened			S1S2B	1	99.2 ± 0.0	NB
A	*Antrostomus vociferus*	Eastern Whip-Poor-Will	Threatened	Threatened	Threatened	S2B	100	11.7 ± 7.0	NB
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Threatened	Threatened	S2B	3	76.7 ± 7.0	NB
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened		S2B	487	2.9 ± 1.0	NB
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2S3	1750	5.5 ± 1.0	NB
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	560	4.0 ± 7.0	NB
A	*Acipenser oxyrinchus*	Atlantic Sturgeon	Threatened		Threatened	S3B,S3N	2	49.5 ± 1.0	NB
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	234	5.6 ± 0.0	NB
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S3M	25	94.9 ± 0.0	NB
A	*Anguilla rostrata*	American Eel	Threatened		Threatened	S4N	129	9.6 ± 1.0	NB
A	*Coturnicops noveboracensis*	Yellow Rail	Special Concern	Special Concern	Special Concern	S1?B,SUM	3	48.2 ± 7.0	NB
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern population	Special Concern	Special Concern	Endangered	S1B,S1S2N,S2M	58	4.2 ± 0.0	NB
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Threatened	S2B	1173	0.5 ± 0.0	NB
A	*Salmo salar pop. 12*	Atlantic Salmon - Gaspe - Southern Gulf of St. Lawrence population	Special Concern		Special Concern	S2S3	456	49.4 ± 0.0	NB
A	*Balaenoptera physalus*	Fin Whale	Special Concern	Special Concern		S2S3	3	98.1 ± 0.0	NB
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Special Concern	S2S3B,S3M	245	10.8 ± 7.0	NB
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern	Special Concern	S2S3N,S3M	53	0.5 ± 0.0	NB
A	*Acipenser brevirostrum*	Shortnose Sturgeon	Special Concern	Special Concern	Special Concern	S3	12	1.7 ± 10.0	NB
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Special Concern	S3	78	1.3 ± 0.0	NB
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Special Concern	S3B	889	2.4 ± 0.0	NB
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S3B	740	6.0 ± 7.0	NB
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Threatened	S3B	1004	4.0 ± 7.0	NB
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern		S3B,S3S4N,SUM	313	6.0 ± 7.0	NB
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Threatened	Threatened	S3B,S4M	531	4.0 ± 7.0	NB
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern	Special Concern		S3M	5	90.8 ± 0.0	NB
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern	Special Concern	S3N	40	33.2 ± 0.0	NB
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Threatened	S3S4B	1777	4.0 ± 7.0	NB
A	*Phocoena phocoena*	Harbour Porpoise	Special Concern		Spec.Concern	S4	28	76.4 ± 100.0	NB
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	85	15.6 ± 0.0	NB
A	*Calidris subruficollis*	Buff-breasted Sandpiper	Special Concern	Special Concern		SNA	14	99.5 ± 1.0	NB
A	*Fulica americana*	American Coot	Not At Risk			S1B	11	61.7 ± 7.0	NB
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Not At Risk	Special Concern	Endangered	S1B,S3M	126	17.9 ± 0.0	NB
A	*Bubo scandiacus*	Snowy Owl	Not At Risk			S1N,S2S3M	11	22.1 ± 1.0	NB
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1S2B	19	4.0 ± 7.0	NB
A	*Buteo lineatus*	Red-shouldered Hawk	Not At Risk			S1S2B	64	6.0 ± 7.0	NB
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk			S2	7	71.0 ± 5.0	NB
A	*Chlidonias niger*	Black Tern	Not At Risk			S2B	348	17.8 ± 5.0	NB
A	*Podiceps grisegena*	Red-necked Grebe	Not At Risk			S2N,S3M	29	19.1 ± 0.0	NB
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3	1	94.9 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Desmognathus fuscus pop. 2*	Northern Dusky Salamander - Quebec / New Brunswick population	Not At Risk			S3	96	9.5 ± 1.0	NB
A	*Megaptera novaeangliae*	Humpback Whale	Not At Risk			S3	1	99.7 ± 1.0	NB
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B,SUM	226	0.5 ± 0.0	NB
A	*Haliaeetus leucocephalus*	Bald Eagle	Not At Risk		Endangered	S4	909	0.5 ± 0.0	NB
A	*Lynx canadensis*	Canada Lynx	Not At Risk		Endangered	S4	34	20.6 ± 0.0	NB
A	*Canis lupus*	Grey Wolf	Not At Risk		Extirpated	SX	3	26.4 ± 1.0	NB
A	*Puma concolor pop. 1*	Cougar - Eastern population	Data Deficient		Endangered	SU	60	1.2 ± 1.0	NB
A	*Calidris canutus rufa*	Red Knot rufa subspecies - Tierra del Fuego / Patagonia wintering population	E,SC	Endangered	Endangered	S2M	19	96.2 ± 0.0	NB
A	*Morone saxatilis*	Striped Bass	E,SC			S3S4B,S3S4N	12	9.6 ± 1.0	NB
A	*Thryothorus ludovicianus*	Carolina Wren				S1	39	10.8 ± 7.0	NB
A	*Salvelinus alpinus*	Arctic Char				S1	1	86.3 ± 1.0	NB
A	*Vireo flavifrons*	Yellow-throated Vireo				S1?B	10	20.4 ± 7.0	NB
A	*Tringa melanoleuca*	Greater Yellowlegs				S1?B,S4S5M	370	5.6 ± 0.0	NB
A	*Aythya americana*	Redhead				S1B	8	70.1 ± 7.0	NB
A	*Gallinula galeata*	Common Gallinule				S1B	28	15.3 ± 0.0	NB
A	*Grus canadensis*	Sandhill Crane				S1B	11	51.6 ± 0.0	NB
A	*Bartramia longicauda*	Upland Sandpiper				S1B	39	30.7 ± 7.0	NB
A	*Phalaropus tricolor*	Wilson's Phalarope				S1B	40	21.0 ± 7.0	NB
A	*Leucophaeus atricilla*	Laughing Gull				S1B	4	18.5 ± 1.0	NB
A	*Rissa tridactyla*	Black-legged Kittiwake				S1B	1	98.8 ± 0.0	NB
A	*Uria aalge*	Common Murre				S1B	1	99.2 ± 0.0	NB
A	*Alca torda*	Razorbill				S1B	1	99.8 ± 0.0	NB
A	*Fratercula arctica*	Atlantic Puffin				S1B	1	99.2 ± 0.0	NB
A	*Progne subis*	Purple Martin				S1B	286	2.0 ± 1.0	NB
A	*Aythya marila*	Greater Scaup				S1B,S2N,S4M	34	40.5 ± 7.0	NB
A	*Oxyura jamaicensis*	Ruddy Duck				S1B,S2S3M	41	17.8 ± 5.0	NB
A	*Aythya affinis*	Lesser Scaup				S1B,S4M	190	17.1 ± 0.0	NB
A	*Eremophila alpestris*	Horned Lark				S1B,S4N,S5M	32	7.6 ± 7.0	NB
A	*Sterna paradisaea*	Arctic Tern				S1B,SUM	4	97.7 ± 5.0	NB
A	*Chroicocephalus ridibundus*	Black-headed Gull				S1N,S2M	4	18.5 ± 1.0	NB
A	*Branta bernicla*	Brant				S1N,S2S3M	17	33.2 ± 0.0	NB
A	*Calidris alba*	Sanderling				S1N,S3S4M	113	19.1 ± 0.0	NB
A	*Butorides virescens*	Green Heron				S1S2B	21	14.8 ± 0.0	NB
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1S2B	9	50.8 ± 0.0	NB
A	*Empidonax traillii*	Willow Flycatcher				S1S2B	99	6.5 ± 1.0	NB
A	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow				S1S2B	26	0.4 ± 0.0	NB
A	*Troglodytes aedon*	House Wren				S1S2B	33	2.1 ± 0.0	NB
A	*Calidris bairdii*	Baird's Sandpiper				S1S2M	21	96.3 ± 0.0	NB
A	*Melanitta americana*	American Scoter				S1S2N,S3M	78	11.2 ± 199.0	NB
A	*Microtus chrotorrhinus*	Rock Vole				S2?	5	92.6 ± 1.0	NB
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2B	553	1.8 ± 2.0	NB
A	*Cistothorus palustris*	Marsh Wren				S2B	391	15.2 ± 0.0	NB
A	*Mimus polyglottos*	Northern Mockingbird				S2B	114	6.0 ± 7.0	NB
A	*Pooecetes gramineus*	Vesper Sparrow				S2B	83	27.0 ± 7.0	NB
A	*Mareca strepera*	Gadwall				S2B,S3M	68	18.1 ± 30.0	NB
A	*Tringa solitaria*	Solitary Sandpiper				S2B,S4S5M	121	3.4 ± 0.0	NB
A	*Pinicola enucleator*	Pine Grosbeak				S2B,S4S5N,S4S5M	69	17.8 ± 0.0	NB
A	*Phalacrocorax carbo*	Great Cormorant				S2N	9	0.5 ± 0.0	NB
A	*Somateria spectabilis*	King Eider				S2N	1	99.1 ± 0.0	NB
A	*Larus hyperboreus*	Glaucous Gull				S2N	91	11.2 ± 50.0	NB
A	*Melanitta perspicillata*	Surf Scoter				S2N,S4M	19	89.4 ± 9.0	NB

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A	*Melanitta deglandi*	White-winged Scoter				S2N,S4M	7	89.4 ± 9.0	NB
A	*Asio otus*	Long-eared Owl				S2S3	16	8.8 ± 0.0	NB
A	*Picoides dorsalis*	American Three-toed Woodpecker				S2S3	26	10.5 ± 7.0	NB
A	*Toxostoma rufum*	Brown Thrasher				S2S3B	108	0.5 ± 0.0	NB
A	*Icterus galbula*	Baltimore Oriole				S2S3B	249	4.0 ± 7.0	NB
A	*Somateria mollissima*	Common Eider				S2S3B,S2S3N,S4M	247	11.2 ± 199.0	NB
A	*Larus delawarensis*	Ring-billed Gull				S2S3B,S4N,S5M	245	0.5 ± 0.0	NB
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	44	20.8 ± 0.0	NB
A	*Calcarius lapponicus*	Lapland Longspur				S2S3N,SUM	12	20.5 ± 0.0	NB
A	*Larus marinus*	Great Black-backed Gull				S3	207	4.0 ± 7.0	NB
A	*Picoides arcticus*	Black-backed Woodpecker				S3	84	2.2 ± 0.0	NB
A	*Loxia curvirostra*	Red Crossbill				S3	129	10.8 ± 7.0	NB
A	*Spinus pinus*	Pine Siskin				S3	255	6.0 ± 7.0	NB
A	*Prosopium cylindraceum*	Round Whitefish				S3	3	45.6 ± 0.0	NB
A	*Salvelinus namaycush*	Lake Trout				S3	7	45.3 ± 0.0	NB
A	*Sorex maritimensis*	Maritime Shrew				S3	1	8.7 ± 1.0	NB
A	*Spatula clypeata*	Northern Shoveler				S3B	91	5.1 ± 0.0	NB
A	*Charadrius vociferus*	Killdeer				S3B	655	4.0 ± 7.0	NB
A	*Tringa semipalmata*	Willet				S3B	16	28.1 ± 0.0	NB
A	*Cepphus grylle*	Black Guillemot				S3B	38	86.7 ± 7.0	NB
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	199	10.8 ± 7.0	NB
A	*Myiarchus crinitus*	Great Crested Flycatcher				S3B	430	2.8 ± 0.0	NB
A	*Piranga olivacea*	Scarlet Tanager				S3B	355	4.0 ± 7.0	NB
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	922	2.6 ± 0.0	NB
A	*Passerina cyanea*	Indigo Bunting				S3B	148	4.0 ± 7.0	NB
A	*Molothrus ater*	Brown-headed Cowbird				S3B	272	4.0 ± 7.0	NB
A	*Setophaga tigrina*	Cape May Warbler				S3B,S4S5M	169	4.0 ± 7.0	NB
A	*Mergus serrator*	Red-breasted Merganser				S3B,S4S5N,S5M	54	3.2 ± 1.0	NB
A	*Anas acuta*	Northern Pintail				S3B,S5M	52	10.8 ± 7.0	NB
A	*Anser caerulescens*	Snow Goose				S3M	6	7.3 ± 0.0	NB
A	*Numenius phaeopus hudsonicus*	Whimbrel				S3M	40	62.0 ± 0.0	NB
A	*Arenaria interpres*	Ruddy Turnstone				S3M	81	61.9 ± 0.0	NB
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	297	5.4 ± 12.0	NB
A	*Calidris melanotos*	Pectoral Sandpiper				S3M	116	5.1 ± 0.0	NB
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	179	28.1 ± 0.0	NB
A	*Phalaropus fulicarius*	Red Phalarope				S3M	2	95.5 ± 0.0	NB
A	*Bucephala albeola*	Bufflehead				S3N	519	0.5 ± 0.0	NB
A	*Calidris maritima*	Purple Sandpiper				S3N	41	89.4 ± 9.0	NB
A	*Uria lomvia*	Thick-billed Murre				S3N,S3M	1	99.9 ± 0.0	NB
A	*Perisoreus canadensis*	Canada Jay				S3S4	391	6.0 ± 7.0	NB
A	*Poecile hudsonicus*	Boreal Chickadee				S3S4	247	14.0 ± 7.0	NB
A	*Eptesicus fuscus*	Big Brown Bat				S3S4	48	0.5 ± 1.0	NB
A	*Synaptomys cooperi*	Southern Bog Lemming				S3S4	19	14.8 ± 1.0	NB
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B	738	3.4 ± 0.0	NB
A	*Vireo gilvus*	Warbling Vireo				S3S4B	307	4.0 ± 7.0	NB
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S4M	766	0.5 ± 0.0	NB
A	*Melospiza lincolnii*	Lincoln's Sparrow				S3S4B,S4M	378	6.0 ± 7.0	NB
A	*Gallinago delicata*	Wilson's Snipe				S3S4B,S5M	967	5.4 ± 12.0	NB
A	*Setophaga striata*	Blackpoll Warbler				S3S4B,S5M	51	10.8 ± 7.0	NB
A	*Pluvialis squatarola*	Black-bellied Plover				S3S4M	212	28.1 ± 0.0	NB
A	*Morus bassanus*	Northern Gannet				SHB	9	57.7 ± 0.0	NB
C	*Quercus macrocarpa - Acer rubrum / Onoclea sensibilis -*	Bur Oak - Red Maple / Sensitive Fern - Northern				S2	1	54.2 ± 0.0	NB

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	Carex arcta Forest	Clustered Sedge Forest							
C	*Acer saccharinum / Onoclea sensibilis - Lysimachia terrestris Forest*	Silver Maple / Sensitive Fern - Swamp Yellow Loosestrife Forest				S3	1	38.4 ± 0.0	NB
C	*Acer saccharum - Fraxinus americana / Gymnocarpium dryopteris - Deparia acrostichoides Forest*	Sugar Maple - White Ash / Common Oak Fern - Silvery Glade Fern Forest				S3	2	79.8 ± 0.0	NB
C	*Acer saccharum - Fraxinus americana / Polystichum acrostichoides Forest*	Sugar Maple - White Ash / Christmas Fern Forest				S3S4	2	61.1 ± 0.0	NB
I	*Bombus bohemicus*	Ashton Cuckoo Bumble Bee	Endangered	Endangered		S1	11	15.9 ± 5.0	NB
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Special Concern	S2S3?B	198	0.6 ± 0.0	NB
I	*Bombus affinis*	Rusty-patched Bumble Bee	Endangered	Endangered		SH	1	17.8 ± 5.0	NB
I	*Gomphurus ventricosus*	Skillet Clubtail	Special Concern	Endangered	Endangered	S2	98	15.6 ± 1.0	NB
I	*Cicindela marginipennis*	Cobblestone Tiger Beetle	Special Concern	Endangered	Endangered	S2S3	218	51.1 ± 0.0	NB
I	*Ophiogomphus howei*	Pygmy Snaketail	Special Concern	Special Concern	Special Concern	S2S3	20	38.4 ± 0.0	NB
I	*Alasmidonta varicosa*	Brook Floater	Special Concern	Special Concern	Special Concern	S3	12	38.4 ± 0.0	NB
I	*Lampsilis cariosa*	Yellow Lampmussel	Special Concern	Special Concern	Special Concern	S3	104	2.7 ± 1.0	NB
I	*Bombus terricola*	Yellow-banded Bumble Bee	Special Concern	Special Concern		S4	143	9.4 ± 0.0	NB
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern			SH	17	15.9 ± 5.0	NB
I	*Appalachina sayana sayana*	Spike-lip Crater Snail	Not At Risk			S3?	3	9.4 ± 0.0	NB
I	*Conotrachelus juglandis*	Butternut Curculio				S1	3	19.9 ± 0.0	NB
I	*Haematopota rara*	Shy Cleg				S1	1	14.8 ± 1.0	NB
I	*Tharsalea dorcas*	Dorcas Copper				S1	20	56.0 ± 0.0	NB
I	*Erora laeta*	Early Hairstreak				S1	11	11.7 ± 7.0	NB
I	*Somatochlora septentrionalis*	Muskeg Emerald				S1	1	21.3 ± 1.0	NB
I	*Polites origenes*	Crossline Skipper				S1?	8	5.7 ± 0.0	NB
I	*Icaricia saepiolus*	Greenish Blue				S1S2	4	17.2 ± 2.0	NB
I	*Pachydiplax longipennis*	Blue Dasher				S1S2	3	45.8 ± 0.0	NB
I	*Cicindela ancocisconensis*	Appalachian Tiger Beetle				S2	4	64.2 ± 0.0	NB
I	*Encyclops caeruleus*	Cerulean Long-horned Beetle				S2	3	15.9 ± 0.0	NB
I	*Scaphinotus viduus*	Bereft Snail-eating Beetle				S2	2	37.6 ± 13.0	NB
I	*Brachyleptura circumdata*	Dark-shouldered Long-horned Beetle				S2	6	34.9 ± 0.0	NB
I	*Satyrium calanus*	Banded Hairstreak				S2	28	5.2 ± 0.0	NB
I	*Satyrium calanus falacer*	Falacer Hairstreak				S2	1	20.4 ± 1.0	NB
I	*Strymon melinus*	Gray Hairstreak				S2	5	38.4 ± 2.0	NB
I	*Somatochlora brevicincta*	Quebec Emerald				S2	1	98.7 ± 0.0	NB
I	*Hybomitra frosti*	Frost's Horse Fly				S2S3	1	55.4 ± 0.0	NB
I	*Tabanus vivax*	Vivacious Horse Fly				S2S3	1	63.1 ± 0.0	NB
I	*Ophiogomphus colubrinus*	Boreal Snaketail				S2S3	40	14.5 ± 0.0	NB
I	*Sphaeroderus nitidicollis*	Polished Snail-eating Beetle				S3	1	46.9 ± 0.0	NB
I	*Orthosoma brunneum*	Moist Long-horned Beetle				S3	1	56.3 ± 5.0	NB
I	*Elaphrus americanus*	Boreal Elaphrus Beetle				S3	1	35.2 ± 0.0	NB
I	*Semanotus terminatus*	Light Long-horned Beetle				S3	1	17.7 ± 0.0	NB
I	*Desmocerus palliatus*	Elderberry Borer				S3	3	16.2 ± 0.0	NB
I	*Agonum excavatum*	Excavated Harp Ground Beetle				S3	1	35.2 ± 0.0	NB
I	*Clivina americana*	America Pedunculate Ground Beetle				S3	1	35.2 ± 0.0	NB
I	*Olisthopus parmatus*	Tawny-bordered Harp Ground Beetle				S3	1	46.9 ± 0.0	NB
I	*Tachys scitulus*	Handsome Riverbank Ground Beetle				S3	1	35.2 ± 0.0	NB
I	*Carabus serratus*	Serrated Ground Beetle				S3	1	64.5 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
I	*Hippodamia parenthesis*	Parenthesis Lady Beetle				S3	3	17.7 ± 0.0	NB
I	*Stenocorus vittiger*	Shrub Long-horned Beetle				S3	1	35.2 ± 0.0	NB
I	*Badister neopulchellus*	Red-black Spotted Beetle				S3	1	35.2 ± 0.0	NB
I	*Gonotropis dorsalis*	Birch Fungus Weevil				S3	1	17.7 ± 0.0	NB
I	*Naemia seriata*	Seaside Lady Beetle				S3	1	98.2 ± 0.0	NB
I	*Ceruchus piceus*	Black Stag Beetle				S3	1	33.9 ± 0.0	NB
I	*Saperda lateralis*	Red-edged Long-horned Beetle				S3	2	83.4 ± 0.0	NB
I	*Epargyreus clarus*	Silver-spotted Skipper				S3	23	57.2 ± 0.0	NB
I	*Hesperia sassacus*	Indian Skipper				S3	22	10.8 ± 7.0	NB
I	*Euphyes bimacula*	Two-spotted Skipper				S3	25	12.1 ± 0.0	NB
I	*Satyrium acadica*	Acadian Hairstreak				S3	19	7.6 ± 2.0	NB
I	*Callophrys eryphon*	Western Pine Elfin				S3	2	79.9 ± 7.0	NB
I	*Plebejus idas*	Northern Blue				S3	2	95.9 ± 0.0	NB
I	*Plebejus idas empetri*	Crowberry Blue				S3	18	90.4 ± 0.0	NB
I	*Argynnis aphrodite*	Aphrodite Fritillary				S3	23	10.8 ± 7.0	NB
I	*Boloria eunomia*	Bog Fritillary				S3	6	46.5 ± 0.0	NB
I	*Boloria bellona*	Meadow Fritillary				S3	81	1.5 ± 0.0	NB
I	*Boloria chariclea*	Arctic Fritillary				S3	1	89.5 ± 2.0	NB
I	*Nymphalis l-album*	Compton Tortoiseshell				S3	17	7.4 ± 2.0	NB
I	*Gomphurus vastus*	Cobra Clubtail				S3	124	1.6 ± 0.0	NB
I	*Celithemis martha*	Martha's Pennant				S3	8	79.8 ± 0.0	NB
I	*Ladona exusta*	White Corporal				S3	10	32.1 ± 0.0	NB
I	*Enallagma pictum*	Scarlet Bluet				S3	10	67.2 ± 0.0	NB
I	*Ischnura kellicotti*	Lilypad Forktail				S3	21	27.5 ± 0.0	NB
I	*Arigomphus furcifer*	Lilypad Clubtail				S3	25	34.0 ± 0.0	NB
I	*Alasmidonta undulata*	Triangle Floater				S3	45	36.0 ± 0.0	NB
I	*Atlanticoncha ochracea*	Tidewater Mucket				S3	168	2.8 ± 0.0	NB
I	*Striatura ferrea*	Black Striate Snail				S3	1	16.0 ± 1.0	NB
I	*Neohelix albolabris*	Whitelip Snail				S3	3	16.0 ± 1.0	NB
I	*Spurwinkia salsa*	Saltmarsh Hydrobe				S3	34	56.8 ± 0.0	NB
I	*Pantala hymenaea*	Spot-Winged Glider				S3B	5	17.7 ± 0.0	NB
I	*Bombus griseocollis*	Brown-belted Bumble Bee				S3S4	2	4.1 ± 0.0	NB
I	*Somatochlora forcipata*	Forcipate Emerald				S3S4	21	8.5 ± 1.0	NB
I	*Somatochlora tenebrosa*	Clamp-Tipped Emerald				S3S4	11	16.0 ± 0.0	NB
N	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened		S1?	154	57.9 ± 0.0	NB
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened		S1S2	3	2.6 ± 1.0	NB
N	*Fuscopannaria leucosticta*	White-rimmed Shingle Lichen	Threatened			S2	229	9.5 ± 0.0	NB
N	*Peltigera hydrothyria*	Eastern Waterfan	Threatened	Threatened		S2S3	9	50.6 ± 0.0	NB
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	9	67.7 ± 0.0	NB
N	*Aphanorrhegma serratum*	a Moss				S1	1	83.5 ± 0.0	NB
N	*Imbribryum muehlenbeckii*	Muehlenbeck's Bryum Moss				S1	1	88.2 ± 1.0	NB
N	*Sphagnum macrophyllum*	Sphagnum				S1	4	68.5 ± 0.0	NB
N	*Coscinodon cribrosus*	Sieve-Toothed Moss				S1	1	99.6 ± 0.0	NB
N	*Leptogium hirsutum*	Jellyskin Lichen				S1	26	75.5 ± 0.0	NB
N	*Coccocarpia palmicola*	Salted Shell Lichen				S1	2	80.3 ± 0.0	NB
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S1?	1	59.3 ± 2.0	NB
N	*Pseudocalliergon trifarium*	Three-ranked Spear Moss				S1?	1	92.8 ± 0.0	NB
N	*Dichelyma falcatum*	a Moss				S1?	2	17.6 ± 10.0	NB
N	*Dicranum bonjeanii*	Bonjean's Broom Moss				S1?	1	17.2 ± 1.0	NB
N	*Entodon brevisetus*	a Moss				S1?	1	86.7 ± 1.0	NB
N	*Oxyrrhynchium hians*	Light Beaked Moss				S1?	2	17.3 ± 1.0	NB
N	*Niphotrichum ericoides*	Dense Rock Moss				S1?	1	33.3 ± 3.0	NB
N	*Splachnum pensylvanicum*	Southern Dung Moss				S1?	2	20.1 ± 0.0	NB
N	*Platylomella lescurii*	a Moss				S1?	1	76.3 ± 1.0	NB
N	*Heterodermia squamulosa*	Scaly Fringe Lichen				S1?	1	78.6 ± 0.0	NB
N	*Pilophorus fibula*	New England Matchstick				S1?	1	85.5 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
		Lichen							
N	*Peltigera venosa*	Fan Pelt Lichen				S1?	2	51.0 ± 0.0	NB
N	*Pallavicinia lyellii*	Lyell's Ribbonwort				S1S2	1	55.2 ± 0.0	NB
N	*Reboulia hemisphaerica*	Purple-margined Liverwort				S1S2	1	93.4 ± 1.0	NB
N	*Solenostoma obovatum*	Egg Flapwort				S1S2	1	90.3 ± 0.0	NB
N	*Brachythecium acuminatum*	Acuminate Ragged Moss				S1S2	3	17.3 ± 10.0	NB
N	*Ptychostomum salinum*	Saltmarsh Bryum				S1S2	1	96.4 ± 1.0	NB
N	*Pseudocampylium radicale*	Long-stalked Fine Wet Moss				S1S2	1	17.3 ± 1.0	NB
N	*Ditrichum pallidum*	Pale Cow-hair Moss				S1S2	3	17.0 ± 1.0	NB
N	*Drummondia prorepens*	a Moss				S1S2	1	70.7 ± 1.0	NB
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S1S2	4	58.8 ± 0.0	NB
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S1S2	3	17.0 ± 1.0	NB
N	*Tomentypnum falcifolium*	Sickle-leaved Golden Moss				S1S2	1	98.3 ± 1.0	NB
N	*Pseudotaxiphyllum distichaceum*	a Moss				S1S2	2	16.0 ± 1.0	NB
N	*Haplocladium microphyllum*	Tiny-leaved Haplocladium Moss				S1S2	1	95.4 ± 1.0	NB
N	*Pilophorus cereolus*	Powdered Matchstick Lichen				S1S2	1	85.5 ± 0.0	NB
N	*Calypogeia neesiana*	Nees' Pouchwort				S1S3	1	95.2 ± 1.0	NB
N	*Fuscocephaloziopsis connivens*	Forcipated Pincerwort				S1S3	1	94.2 ± 0.0	NB
N	*Cephaloziella elachista*	Spurred Threadwort				S1S3	1	93.2 ± 5.0	NB
N	*Porella pinnata*	Pinnate Scalewort				S1S3	2	65.0 ± 1.0	NB
N	*Amphidium mougeotii*	a Moss				S2	2	88.7 ± 8.0	NB
N	*Anomodon viticulosus*	a Moss				S2	6	93.5 ± 0.0	NB
N	*Cirriphyllum piliferum*	Hair-pointed Moss				S2	1	64.4 ± 1.0	NB
N	*Cynodontium strumiferum*	Strumose Dogtooth Moss				S2	1	88.7 ± 8.0	NB
N	*Dicranella palustris*	Drooping-Leaved Fork Moss				S2	2	72.6 ± 100.0	NB
N	*Didymodon ferrugineus*	Rusty Beard Moss				S2	3	61.6 ± 0.0	NB
N	*Ditrichum flexicaule*	Flexible Cow-hair Moss				S2	1	89.8 ± 1.0	NB
N	*Anomodon tristis*	a Moss				S2	1	37.3 ± 1.0	NB
N	*Hypnum pratense*	Meadow Plait Moss				S2	3	71.9 ± 1.0	NB
N	*Isothecium myosuroides*	Slender Mouse-tail Moss				S2	2	89.8 ± 1.0	NB
N	*Meesia triquetra*	Three-ranked Cold Moss				S2	2	57.1 ± 0.0	NB
N	*Physcomitrium immersum*	a Moss				S2	7	5.2 ± 0.0	NB
N	*Platydictya jungermannioides*	False Willow Moss				S2	1	96.3 ± 0.0	NB
N	*Seligeria calcarea*	Chalk Brittle Moss				S2	1	89.8 ± 1.0	NB
N	*Seligeria brevifolia*	a Moss				S2	1	62.4 ± 1.0	NB
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S2	3	91.3 ± 1.0	NB
N	*Tetraplodon mnioides*	Entire-leaved Nitrogen Moss				S2	3	92.8 ± 0.0	NB
N	*Thamnobryum alleghaniense*	a Moss				S2	2	16.3 ± 0.0	NB
N	*Tortula mucronifolia*	Mucronate Screw Moss				S2	1	98.5 ± 0.0	NB
N	*Ulota phyllantha*	a Moss				S2	2	96.3 ± 0.0	NB
N	*Anomobryum julaceum*	Slender Silver Moss				S2	1	17.3 ± 1.0	NB
N	*Usnea ceratina*	Warty Beard Lichen				S2	1	79.5 ± 0.0	NB
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S2	3	8.5 ± 1.0	NB
N	*Leptogium milligranum*	Stretched Jellyskin Lichen				S2	6	59.2 ± 0.0	NB
N	*Nephroma laevigatum*	Mustard Kidney Lichen				S2	2	55.4 ± 0.0	NB
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S2	3	51.0 ± 0.0	NB
N	*Anomodon minor*	Blunt-leaved Anomodon Moss				S2?	1	71.7 ± 1.0	NB
N	*Ptychostomum pallescens*	Tall Clustered Bryum				S2?	2	54.4 ± 1.0	NB
N	*Dichelyma capillaceum*	Hairlike Dichelyma Moss				S2?	2	32.2 ± 4.0	NB
N	*Dicranum spurium*	Spurred Broom Moss				S2?	3	88.9 ± 2.0	NB
N	*Schistostega pennata*	Luminous Moss				S2?	5	17.3 ± 1.0	NB
N	*Seligeria diversifolia*	a Moss				S2?	1	61.1 ± 0.0	NB
N	*Sphagnum angermanicum*	a Peatmoss				S2?	2	66.4 ± 1.0	NB

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N	*Plagiomnium rostratum*	Long-beaked Leafy Moss				S2?	1	99.0 ± 1.0	NB
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2?	7	5.6 ± 0.0	NB
N	*Physcia subtilis*	Slender Rosette Lichen				S2?	1	59.2 ± 0.0	NB
N	*Buxbaumia aphylla*	Brown Shield Moss				S2S3	2	79.9 ± 15.0	NB
N	*Calliergonella cuspidata*	Common Large Wetland Moss				S2S3	5	75.9 ± 0.0	NB
N	*Drepanocladus polygamus*	Polygamous Hook Moss				S2S3	1	56.5 ± 1.0	NB
N	*Palustriella falcata*	Curled Hook Moss				S2S3	1	89.8 ± 1.0	NB
N	*Didymodon rigidulus*	Rigid Screw Moss				S2S3	3	18.2 ± 8.0	NB
N	*Ephemerum serratum*	a Moss				S2S3	1	5.3 ± 0.0	NB
N	*Fissidens bushii*	Bush's Pocket Moss				S2S3	6	62.3 ± 1.0	NB
N	*Isopterygiopsis pulchella*	Neat Silk Moss				S2S3	1	71.0 ± 1.0	NB
N	*Neckera complanata*	a Moss				S2S3	3	89.8 ± 1.0	NB
N	*Orthotrichum elegans*	Showy Bristle Moss				S2S3	5	16.5 ± 3.0	NB
N	*Codriophorus fascicularis*	Clustered Rock Moss				S2S3	1	88.2 ± 0.0	NB
N	*Scorpidium scorpioides*	Hooked Scorpion Moss				S2S3	5	75.7 ± 1.0	NB
N	*Seligeria campylopoda*	a Moss				S2S3	1	61.6 ± 0.0	NB
N	*Sphagnum centrale*	Central Peat Moss				S2S3	1	80.1 ± 0.0	NB
N	*Sphagnum subfulvum*	a Peatmoss				S2S3	4	83.7 ± 0.0	NB
N	*Taxiphyllum deplanatum*	Imbricate Yew-leaved Moss				S2S3	2	61.5 ± 0.0	NB
N	*Zygodon viridissimus*	a Moss				S2S3	2	82.3 ± 5.0	NB
N	*Schistidium agassizii*	Elf Bloom Moss				S2S3	2	82.0 ± 2.0	NB
N	*Loeskeobryum brevirostre*	a Moss				S2S3	1	89.8 ± 1.0	NB
N	*Sphaerophorus globosus*	Northern Coral Lichen				S2S3	1	94.2 ± 0.0	NB
N	*Dendriscocaulon umhausense*	a lichen				S2S3	1	88.7 ± 0.0	NB
N	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S2S3	3	73.0 ± 0.0	NB
N	*Punctelia caseana*					S2S3	3	74.1 ± 0.0	NB
N	*Cynodontium tenellum*	Delicate Dogtooth Moss				S3	1	96.4 ± 1.0	NB
N	*Hypnum curvifolium*	Curved-leaved Plait Moss				S3	2	75.5 ± 0.0	NB
N	*Tortella fragilis*	Fragile Twisted Moss				S3	1	37.8 ± 0.0	NB
N	*Schistidium maritimum*	a Moss				S3	2	96.3 ± 0.0	NB
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	8	75.1 ± 0.0	NB
N	*Solorina saccata*	Woodland Owl Lichen				S3	1	51.0 ± 0.0	NB
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S3	2	83.9 ± 0.0	NB
N	*Cladonia strepsilis*	Olive Cladonia Lichen				S3	2	88.9 ± 2.0	NB
N	*Hypotrachyna catawbiensis*	Powder-tipped Antler Lichen				S3	1	88.9 ± 2.0	NB
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	2	50.9 ± 0.0	NB
N	*Peltigera degenii*	Lustrous Pelt Lichen				S3	1	78.5 ± 0.0	NB
N	*Leptogium laceroides*	Short-bearded Jellyskin Lichen				S3	8	61.9 ± 0.0	NB
N	*Peltigera membranacea*	Membranous Pelt Lichen				S3	8	18.6 ± 0.0	NB
N	*Cladonia botrytes*	Wooden Soldiers Lichen				S3	1	84.1 ± 0.0	NB
N	*Cladonia deformis*	Lesser Sulphur-cup Lichen				S3	1	88.9 ± 2.0	NB
N	*Aulacomnium androgynum*	Little Groove Moss				S3?	6	80.3 ± 1.0	NB
N	*Dicranella rufescens*	Red Forklet Moss				S3?	2	17.5 ± 4.0	NB
N	*Sphagnum lescurii*	a Peatmoss				S3?	2	80.2 ± 1.0	NB
N	*Sphagnum inundatum*	a Sphagnum				S3?	2	46.9 ± 0.0	NB
N	*Rostania occultata*	Crusted Tarpaper Lichen				S3?	1	5.6 ± 0.0	NB
N	*Cystocoleus ebeneus*	Rockgossamer Lichen				S3?	1	76.7 ± 0.0	NB
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3?	6	5.1 ± 0.0	NB
N	*Anomodon rugelii*	Rugel's Anomodon Moss				S3S4	9	72.8 ± 0.0	NB
N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3S4	1	18.2 ± 8.0	NB
N	*Brachytheciastrum velutinum*	Velvet Ragged Moss				S3S4	6	18.6 ± 4.0	NB
N	*Dicranella cerviculata*	a Moss				S3S4	3	96.4 ± 1.0	NB
N	*Dicranella varia*	a Moss				S3S4	3	99.6 ± 2.0	NB

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N	*Dicranum majus*	Greater Broom Moss				S3S4	4	79.9 ± 15.0	NB
N	*Fissidens bryoides*	Lesser Pocket Moss				S3S4	4	5.0 ± 0.0	NB
N	*Elodium blandowii*	Blandow's Bog Moss				S3S4	3	71.0 ± 1.0	NB
N	*Heterocladium dimorphum*	Dimorphous Tangle Moss				S3S4	1	82.0 ± 2.0	NB
N	*Isopterygiopsis muelleriana*	a Moss				S3S4	7	18.6 ± 4.0	NB
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	2	88.7 ± 8.0	NB
N	*Orthotrichum speciosum*	Showy Bristle Moss				S3S4	1	5.9 ± 0.0	NB
N	*Physcomitrium pyriforme*	Pear-shaped Urn Moss				S3S4	7	5.2 ± 0.0	NB
N	*Pogonatum dentatum*	Mountain Hair Moss				S3S4	1	96.4 ± 1.0	NB
N	*Sphagnum torreyanum*	a Peatmoss				S3S4	4	80.5 ± 1.0	NB
N	*Sphagnum austinii*	Austin's Peat Moss				S3S4	1	97.3 ± 1.0	NB
N	*Sphagnum contortum*	Twisted Peat Moss				S3S4	1	95.1 ± 0.0	NB
N	*Sphagnum quinquefarium*	Five-ranked Peat Moss				S3S4	1	89.8 ± 1.0	NB
N	*Tetraphis geniculata*	Geniculate Four-tooth Moss				S3S4	5	92.1 ± 0.0	NB
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S3S4	1	96.4 ± 1.0	NB
N	*Tomentypnum nitens*	Golden Fuzzy Fen Moss				S3S4	1	58.0 ± 3.0	NB
N	*Weissia controversa*	Green-Cushioned Weissia				S3S4	2	5.3 ± 0.0	NB
N	*Abietinella abietina*	Wiry Fern Moss				S3S4	1	58.6 ± 0.0	NB
N	*Trichostomum tenuirostre*	Acid-Soil Moss				S3S4	5	61.5 ± 0.0	NB
N	*Scorpidium revolvens*	Limprichtia Moss				S3S4	2	62.5 ± 0.0	NB
N	*Rauiella scita*	Smaller Fern Moss				S3S4	6	65.8 ± 3.0	NB
N	*Pannaria rubiginosa*	Brown-eyed Shingle Lichen				S3S4	30	8.6 ± 0.0	NB
N	*Pseudocyphellaria holarctica*	Yellow Specklebelly Lichen				S3S4	125	34.1 ± 0.0	NB
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S3S4	1	53.6 ± 0.0	NB
N	*Montanelia panniformis*	Shingled Camouflage Lichen				S3S4	1	76.7 ± 0.0	NB
N	*Cladonia terrae-novae*	Newfoundland Reindeer Lichen				S3S4	2	88.9 ± 2.0	NB
N	*Cladonia floerkeana*	Gritty British Soldiers Lichen				S3S4	1	90.6 ± 0.0	NB
N	*Cladonia parasitica*	Fence-rail Lichen				S3S4	1	86.6 ± 0.0	NB
N	*Nephroma parile*	Powdery Kidney Lichen				S3S4	19	5.6 ± 0.0	NB
N	*Nephroma resupinatum*	a lichen				S3S4	8	57.0 ± 0.0	NB
N	*Protopannaria pezizoides*	Brown-gray Moss-shingle Lichen				S3S4	13	67.6 ± 0.0	NB
N	*Parmelia fertilis*	Fertile Shield Lichen				S3S4	1	89.6 ± 0.0	NB
N	*Usnea strigosa*	Bushy Beard Lichen				S3S4	3	76.0 ± 0.0	NB
N	*Fuscopannaria sorediata*	a Lichen				S3S4	10	8.5 ± 1.0	NB
N	*Pannaria conoplea*	Mealy-rimmed Shingle Lichen				S3S4	52	48.0 ± 0.0	NB
N	*Physcia tenella*	Fringed Rosette Lichen				S3S4	1	98.7 ± 0.0	NB
N	*Anaptychia palmulata*	Shaggy Fringed Lichen				S3S4	17	61.9 ± 0.0	NB
N	*Peltigera neopolydactyla*	Undulating Pelt Lichen				S3S4	1	88.9 ± 2.0	NB
N	*Grimmia anodon*	Toothless Grimmia Moss				SH	2	98.2 ± 10.0	NB
N	*Leucodon brachypus*	a Moss				SH	2	29.8 ± 10.0	NB
N	*Orthotrichum gymnostomum*	a Moss				SH	1	31.7 ± 10.0	NB
N	*Thelia hirtella*	a Moss				SH	1	72.6 ± 100.0	NB
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				SH	3	97.7 ± 10.0	NB
P	*Juglans cinerea*	Butternut	Endangered	Endangered	Endangered	S1	768	1.3 ± 0.0	NB
P	*Polemonium vanbruntiae*	Van Brunt's Jacob's-ladder	Threatened	Threatened	Threatened	S1	72	85.9 ± 1.0	NB
P	*Fraxinus nigra*	Black Ash	Threatened			S3S4	1097	2.5 ± 1.0	NB
P	*Symphyotrichum praealtum*	Willow-leaved Aster	Threatened	Threatened		SNA	1	95.7 ± 1.0	NB
P	*Isoetes prototypus*	Prototype Quillwort	Special Concern	Special Concern	Endangered	S1	23	12.6 ± 0.0	NB
P	*Symphyotrichum anticostense*	Anticosti Aster	Special Concern	Special Concern	Endangered	S3	63	1.7 ± 0.0	NB
P	*Pterospora andromedea*	Woodland Pinedrops			Endangered	S1	33	1.5 ± 0.0	NB
P	*Cryptotaenia canadensis*	Canada Honewort				S1	4	55.8 ± 1.0	NB
P	*Antennaria parlinii ssp. fallax*	Parlin's Pussytoes				S1	7	66.6 ± 0.0	NB
P	*Antennaria howellii ssp.*	Pussy-Toes				S1	1	86.6 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
	petaloidea								
P	*Bidens discoidea*	Swamp Beggarticks				S1	4	45.9 ± 0.0	NB
P	*Pseudognaphalium obtusifolium*	Eastern Cudweed				S1	2	68.1 ± 0.0	NB
P	*Helianthus decapetalus*	Ten-rayed Sunflower				S1	21	3.8 ± 1.0	NB
P	*Hieracium paniculatum*	Panicled Hawkweed				S1	4	18.0 ± 0.0	NB
P	*Andersonglossum boreale*	Northern Wild Comfrey				S1	14	64.6 ± 0.0	NB
P	*Barbarea orthoceras*	American Yellow Rocket				S1	1	96.9 ± 1.0	NB
P	*Cardamine parviflora*	Small-flowered Bittercress				S1	3	81.7 ± 0.0	NB
P	*Cardamine concatenata*	Cut-leaved Toothwort				S1	15	9.6 ± 1.0	NB
P	*Draba arabisans*	Rock Whitlow-Grass				S1	3	90.5 ± 0.0	NB
P	*Draba cana*	Lance-leaved Draba				S1	10	15.7 ± 0.0	NB
P	*Draba glabella*	Rock Whitlow-Grass				S1	8	49.1 ± 1.0	NB
P	*Mononeuria groenlandica*	Greenland Stitchwort				S1	2	79.7 ± 0.0	NB
P	*Chenopodiastrum simplex*	Maple-leaved Goosefoot				S1	7	8.6 ± 1.0	NB
P	*Blitum capitatum*	Strawberry-Blite				S1	5	16.7 ± 6.0	NB
P	*Callitriche terrestris*	Terrestrial Water-Starwort				S1	1	83.6 ± 0.0	NB
P	*Hypericum virginicum*	Virginia St. John's-wort				S1	7	36.0 ± 0.0	NB
P	*Viburnum acerifolium*	Maple-leaved Viburnum				S1	11	95.8 ± 1.0	NB
P	*Drosera anglica*	English Sundew				S1	2	57.0 ± 0.0	NB
P	*Drosera linearis*	Slender-Leaved Sundew				S1	6	57.0 ± 0.0	NB
P	*Corema conradii*	Broom Crowberry				S1	1	99.7 ± 10.0	NB
P	*Vaccinium boreale*	Northern Blueberry				S1	1	81.6 ± 0.0	NB
P	*Vaccinium corymbosum*	Highbush Blueberry				S1	9	65.8 ± 0.0	NB
P	*Hylodesmum glutinosum*	Large Tick-trefoil				S1	9	58.0 ± 1.0	NB
P	*Lespedeza capitata*	Round-headed Bush-clover				S1	11	58.4 ± 0.0	NB
P	*Gentiana rubricaulis*	Purple-stemmed Gentian				S1	18	60.6 ± 0.0	NB
P	*Ribes cynosbati*	Prickly Gooseberry				S1	1	61.2 ± 0.0	NB
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S1	1	84.3 ± 0.0	NB
P	*Pycnanthemum virginianum*	Virginia Mountain Mint				S1	4	81.8 ± 0.0	NB
P	*Decodon verticillatus*	Swamp Loosestrife				S1	4	35.2 ± 0.0	NB
P	*Polygala verticillata*	Whorled Milkwort				S1	2	64.3 ± 0.0	NB
P	*Lysimachia hybrida*	Lowland Yellow Loosestrife				S1	17	80.5 ± 0.0	NB
P	*Lysimachia quadrifolia*	Whorled Yellow Loosestrife				S1	14	78.6 ± 0.0	NB
P	*Hepatica acutiloba*	Sharp-lobed Hepatica				S1	11	77.1 ± 0.0	NB
P	*Coptidium lapponicum*	Lapland Buttercup				S1	1	87.3 ± 1.0	NB
P	*Crataegus jonesiae*	Jones' Hawthorn				S1	6	15.6 ± 1.0	NB
P	*Potentilla canadensis*	Canada Cinquefoil				S1	2	79.9 ± 0.0	NB
P	*Rubus flagellaris*	Northern Dewberry				S1	3	16.9 ± 0.0	NB
P	*Galium brevipes*	Limestone Swamp Bedstraw				S1	6	50.4 ± 5.0	NB
P	*Saxifraga paniculata ssp. laestadii*	Laestadius' Saxifrage				S1	8	89.8 ± 1.0	NB
P	*Agalinis tenuifolia*	Slender Agalinis				S1	9	15.4 ± 0.0	NB
P	*Gratiola lutea*	Golden Hedge-hyssop				S1	2	84.6 ± 0.0	NB
P	*Pedicularis canadensis*	Canada Lousewort				S1	23	9.5 ± 0.0	NB
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S1	15	14.4 ± 0.0	NB
P	*Carex annectens*	Yellow-Fruited Sedge				S1	1	62.2 ± 0.0	NB
P	*Carex backii*	Rocky Mountain Sedge				S1	5	15.5 ± 1.0	NB
P	*Carex blanda*	Eastern Woodland Sedge				S1	1	62.0 ± 0.0	NB
P	*Carex merritt-fernaldii*	Merritt Fernald's Sedge				S1	2	93.6 ± 0.0	NB
P	*Carex salina*	Saltmarsh Sedge				S1	2	98.7 ± 1.0	NB
P	*Carex sterilis*	Sterile Sedge				S1	12	1.7 ± 0.0	NB
P	*Carex grisea*	Inflated Narrow-leaved Sedge				S1	15	9.5 ± 1.0	NB
P	*Carex saxatilis*	Russet Sedge				S1	14	90.0 ± 10.0	NB
P	*Cyperus diandrus*	Low Flatsedge				S1	7	4.4 ± 0.0	NB
P	*Eleocharis flavescens var. olivacea*	Bright-green Spikerush				S1	3	85.6 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Rhynchospora capillacea*	Slender Beakrush				S1	3	2.5 ± 0.0	NB
P	*Scirpus pendulus*	Hanging Bulrush				S1	1	85.3 ± 0.0	NB
P	*Sisyrinchium angustifolium*	Narrow-leaved Blue-eyed-grass				S1	6	35.2 ± 0.0	NB
P	*Juncus greenei*	Greene's Rush				S1	1	93.9 ± 0.0	NB
P	*Juncus subtilis*	Creeping Rush				S1	1	66.1 ± 5.0	NB
P	*Allium canadense*	Canada Garlic				S1	11	1.7 ± 0.0	NB
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S1	3	16.0 ± 0.0	NB
P	*Malaxis monophyllos var. brachypoda*	North American White Adder's-mouth				S1	12	38.9 ± 0.0	NB
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S1	14	29.9 ± 10.0	NB
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S1	4	15.6 ± 1.0	NB
P	*Spiranthes casei*	Case's Ladies'-Tresses				S1	6	9.5 ± 0.0	NB
P	*Bromus pubescens*	Hairy Wood Brome Grass				S1	6	53.7 ± 0.0	NB
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S1	55	37.5 ± 0.0	NB
P	*Danthonia compressa*	Flattened Oat Grass				S1	4	35.6 ± 0.0	NB
P	*Dichanthelium xanthophysum*	Slender Panic Grass				S1	6	70.7 ± 0.0	NB
P	*Dichanthelium dichotomum*	Forked Panic Grass				S1	20	85.8 ± 1.0	NB
P	*Glyceria obtusa*	Atlantic Manna Grass				S1	6	69.4 ± 0.0	NB
P	*Sporobolus compositus*	Rough Dropseed				S1	17	0.0 ± 0.0	NB
P	*Potamogeton friesii*	Fries' Pondweed				S1	6	13.8 ± 5.0	NB
P	*Potamogeton nodosus*	Long-leaved Pondweed				S1	18	22.9 ± 1.0	NB
P	*Potamogeton strictifolius*	Straight-leaved Pondweed				S1	2	89.7 ± 0.0	NB
P	*Xyris difformis*	Bog Yellow-eyed-grass				S1	5	82.3 ± 0.0	NB
P	*Asplenium ruta-muraria var. cryptolepis*	Wallrue Spleenwort				S1	4	89.8 ± 1.0	NB
P	*Dryopteris clintoniana*	Clinton's Wood Fern				S1	13	5.4 ± 0.0	NB
P	*Sceptridium oneidense*	Blunt-lobed Moonwort				S1	8	32.3 ± 0.0	NB
P	*Sceptridium rugulosum*	Rugulose Grapefern				S1	5	48.2 ± 0.0	NB
P	*Selaginella rupestris*	Rock Spikemoss				S1	7	0.3 ± 0.0	NB
P	*Cuscuta campestris*	Field Dodder				S1?	3	61.8 ± 10.0	NB
P	*Polygonum aviculare ssp. neglectum*	Narrow-leaved Knotweed				S1?	7	17.2 ± 5.0	NB
P	*Galium trifidum ssp. subbiflorum*	Three-petaled Bedstraw				S1?	1	68.6 ± 1.0	NB
P	*Alisma subcordatum*	Southern Water Plantain				S1?	8	3.4 ± 0.0	NB
P	*Carex laxiflora*	Loose-Flowered Sedge				S1?	3	55.8 ± 0.0	NB
P	*Carex appalachica*	Appalachian Sedge				S1?	1	68.1 ± 0.0	NB
P	*Sisyrinchium mucronatum*	Michaux's Blue-eyed-grass				S1?	3	65.4 ± 0.0	NB
P	*Wolffia columbiana*	Columbian Watermeal				S1?	7	15.4 ± 0.0	NB
P	*Galium kamtschaticum*	Northern Wild Licorice				S1S2	2	51.4 ± 0.0	NB
P	*Galearis spectabilis*	Showy Orchis				S1S2	75	49.0 ± 0.0	NB
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S1S2	3	48.1 ± 0.0	NB
P	*Potamogeton bicupulatus*	Snailseed Pondweed				S1S2	5	59.6 ± 0.0	NB
P	*Eriophorum russeolum ssp. albidum*	Smooth-fruited Russet Cottongrass				S1S3	2	73.6 ± 0.0	NB
P	*Spiranthes cernua*	Nodding Ladies'-Tresses				S1S3	16	9.5 ± 0.0	NB
P	*Spiranthes arcisepala*	Appalachian Ladies'-tresses				S1S3	5	22.2 ± 0.0	NB
P	*Neottia bifolia*	Southern Twayblade			Endangered	S2	16	24.9 ± 0.0	NB
P	*Sanicula trifoliata*	Large-Fruited Sanicle				S2	26	49.0 ± 0.0	NB
P	*Sanicula odorata*	Clustered Sanicle				S2	28	5.7 ± 0.0	NB
P	*Hieracium robinsonii*	Robinson's Hawkweed				S2	1	69.4 ± 0.0	NB
P	*Betula minor*	Dwarf White Birch				S2	1	10.1 ± 0.0	NB
P	*Atriplex glabriuscula var. franktonii*	Frankton's Saltbush				S2	1	95.7 ± 1.0	NB
P	*Hypericum x dissimulatum*	Disguised St. John's-wort				S2	3	31.7 ± 0.0	NB

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P	*Viburnum dentatum var. lucidum*	Northern Arrow-Wood				S2	190	47.0 ± 0.0	NB
P	*Astragalus eucosmus*	Elegant Milk-vetch				S2	12	1.8 ± 0.0	NB
P	*Quercus macrocarpa*	Bur Oak				S2	178	1.2 ± 0.0	NB
P	*Nuphar x rubrodisca*	Red-disk Yellow Pond-lily				S2	17	22.1 ± 0.0	NB
P	*Polygaloides paucifolia*	Fringed Milkwort				S2	21	20.3 ± 0.0	NB
P	*Persicaria amphibia var. emersa*	Long-root Smartweed				S2	64	19.4 ± 1.0	NB
P	*Geum fragarioides*	Barren Strawberry				S2	27	48.9 ± 0.0	NB
P	*Micranthes virginiensis*	Early Saxifrage				S2	14	0.6 ± 1.0	NB
P	*Scrophularia lanceolata*	Lance-leaved Figwort				S2	12	10.6 ± 100.0	NB
P	*Viola canadensis*	Canada Violet				S2	86	61.9 ± 0.0	NB
P	*Carex cephaloidea*	Thin-leaved Sedge				S2	33	12.7 ± 0.0	NB
P	*Carex albicans var. emmonsii*	White-tinged Sedge				S2	5	49.7 ± 0.0	NB
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S2	69	46.7 ± 0.0	NB
P	*Calypso bulbosa var. americana*	Calypso				S2	40	15.6 ± 1.0	NB
P	*Coeloglossum viride*	Long-bracted Frog Orchid				S2	7	19.0 ± 5.0	NB
P	*Cypripedium parviflorum var. makasin*	Small Yellow Lady's-Slipper				S2	15	17.2 ± 1.0	NB
P	*Platanthera huronensis*	Fragrant Green Orchid				S2	3	39.0 ± 0.0	NB
P	*Elymus hystrix*	Spreading Wild Rye				S2	51	47.4 ± 1.0	NB
P	*Festuca subverticillata*	Nodding Fescue				S2	32	71.9 ± 0.0	NB
P	*Botrychium minganense*	Mingan Moonwort				S2	1	99.8 ± 0.0	NB
P	*Schizaea pusilla*	Little Curlygrass Fern				S2	23	97.4 ± 0.0	NB
P	*Coryphopteris simulata*	Bog Fern				S2	26	45.1 ± 0.0	NB
P	*Toxicodendron radicans var. radicans*	Eastern Poison Ivy				S2?	15	5.1 ± 1.0	NB
P	*Symphyotrichum novi-belgii var. crenifolium*	New York Aster				S2?	3	15.2 ± 1.0	NB
P	*Humulus lupulus var. lupuloides*	Common Hop				S2?	5	14.8 ± 5.0	NB
P	*Rubus x recurvicaulis*	arching dewberry				S2?	5	48.5 ± 1.0	NB
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2S3	10	5.4 ± 5.0	NB
P	*Symphyotrichum racemosum*	Small White Aster				S2S3	13	32.2 ± 0.0	NB
P	*Canadanthus modestus*	Great Northern Aster				S2S3	12	74.2 ± 0.0	NB
P	*Alnus serrulata*	Smooth Alder				S2S3	62	49.1 ± 1.0	NB
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2S3	2	89.1 ± 0.0	NB
P	*Gentiana linearis*	Narrow-Leaved Gentian				S2S3	19	17.6 ± 1.0	NB
P	*Hedeoma pulegioides*	American False Pennyroyal				S2S3	13	12.1 ± 0.0	NB
P	*Aphyllon uniflorum*	One-flowered Broomrape				S2S3	14	47.9 ± 1.0	NB
P	*Polygala senega*	Seneca Snakeroot				S2S3	34	12.1 ± 1.0	NB
P	*Persicaria careyi*	Carey's Smartweed				S2S3	17	17.4 ± 1.0	NB
P	*Hepatica americana*	Round-lobed Hepatica				S2S3	69	1.8 ± 1.0	NB
P	*Ranunculus sceleratus*	Cursed Buttercup				S2S3	8	17.4 ± 0.0	NB
P	*Rosa acicularis ssp. sayi*	Prickly Rose				S2S3	35	67.2 ± 0.0	NB
P	*Cephalanthus occidentalis*	Common Buttonbush				S2S3	70	35.5 ± 0.0	NB
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2S3	7	6.2 ± 0.0	NB
P	*Euphrasia randii*	Rand's Eyebright				S2S3	2	95.9 ± 0.0	NB
P	*Dirca palustris*	Eastern Leatherwood				S2S3	112	1.6 ± 1.0	NB
P	*Phryma leptostachya*	American Lopseed				S2S3	108	5.5 ± 0.0	NB
P	*Verbena urticifolia*	White Vervain				S2S3	35	4.0 ± 0.0	NB
P	*Viola novae-angliae*	New England Violet				S2S3	18	53.5 ± 10.0	NB
P	*Carex comosa*	Bearded Sedge				S2S3	8	72.8 ± 0.0	NB
P	*Carex rostrata*	Narrow-leaved Beaked				S2S3	10	68.3 ± 0.0	NB

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		Sedge							
P	*Carex vacillans*	Estuarine Sedge				S2S3	2	88.7 ± 1.0	NB
P	*Scirpus atrovirens*	Dark-green Bulrush				S2S3	2	83.7 ± 0.0	NB
P	*Juncus ranarius*	Seaside Rush				S2S3	1	93.4 ± 0.0	NB
P	*Allium tricoccum*	Wild Leek				S2S3	22	0.6 ± 0.0	NB
P	*Corallorhiza maculata var. occidentalis*	Spotted Coralroot				S2S3	12	15.2 ± 1.0	NB
P	*Corallorhiza maculata var. maculata*	Spotted Coralroot				S2S3	7	15.6 ± 1.0	NB
P	*Elymus canadensis*	Canada Wild Rye				S2S3	26	0.2 ± 1.0	NB
P	*Piptatheropsis canadensis*	Canada Ricegrass				S2S3	6	39.2 ± 1.0	NB
P	*Puccinellia phryganodes ssp. neoarctica*	Creeping Alkali Grass				S2S3	7	86.4 ± 0.0	NB
P	*Poa glauca*	Glaucous Blue Grass				S2S3	1	99.6 ± 2.0	NB
P	*Piptatheropsis pungens*	Slender Ricegrass				S2S3	5	68.9 ± 0.0	NB
P	*Potamogeton vaseyi*	Vasey's Pondweed				S2S3	12	12.8 ± 0.0	NB
P	*Isoetes tuckermanii ssp. acadiensis*	Acadian Quillwort				S2S3	10	18.2 ± 1.0	NB
P	*Botrychium tenebrosum*	Swamp Moonwort				S2S3	1	77.0 ± 0.0	NB
P	*Panax trifolius*	Dwarf Ginseng				S3	16	14.4 ± 0.0	NB
P	*Artemisia campestris ssp. caudata*	Tall Wormwood				S3	148	4.4 ± 0.0	NB
P	*Artemisia campestris*	Field Wormwood				S3	1	54.5 ± 0.0	NB
P	*Nabalus racemosus*	Glaucous Rattlesnakeroot				S3	75	0.8 ± 0.0	NB
P	*Solidago racemosa*	Racemose Goldenrod				S3	23	0.6 ± 1.0	NB
P	*Tanacetum bipinnatum ssp. huronense*	Lake Huron Tansy				S3	44	0.2 ± 1.0	NB
P	*Ionactis linariifolia*	Flax-leaved Aster				S3	59	14.4 ± 0.0	NB
P	*Pseudognaphalium macounii*	Macoun's Cudweed				S3	12	9.4 ± 0.0	NB
P	*Impatiens pallida*	Pale Jewelweed				S3	6	16.3 ± 0.0	NB
P	*Turritis glabra*	Tower Mustard				S3	14	54.0 ± 0.0	NB
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S3	19	1.3 ± 1.0	NB
P	*Cardamine maxima*	Large Toothwort				S3	132	2.5 ± 0.0	NB
P	*Boechera stricta*	Drummond's Rockcress				S3	12	0.1 ± 0.0	NB
P	*Sagina nodosa*	Knotted Pearlwort				S3	2	93.4 ± 0.0	NB
P	*Stellaria humifusa*	Saltmarsh Starwort				S3	5	86.4 ± 0.0	NB
P	*Stellaria longifolia*	Long-leaved Starwort				S3	15	17.3 ± 10.0	NB
P	*Oxybasis rubra*	Red Goosefoot				S3	4	89.6 ± 1.0	NB
P	*Hudsonia tomentosa*	Woolly Beach-heath				S3	4	80.1 ± 0.0	NB
P	*Cornus obliqua*	Silky Dogwood				S3	286	50.0 ± 1.0	NB
P	*Lonicera oblongifolia*	Swamp Fly Honeysuckle				S3	149	45.5 ± 0.0	NB
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	182	0.9 ± 0.0	NB
P	*Viburnum lentago*	Nannyberry				S3	133	42.2 ± 0.0	NB
P	*Rhodiola rosea*	Roseroot				S3	10	89.0 ± 5.0	NB
P	*Astragalus alpinus*	Alpine Milk-vetch				S3	3	5.9 ± 0.0	NB
P	*Astragalus alpinus var. brunetianus*	Alpine Milk-Vetch				S3	14	4.9 ± 1.0	NB
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S3	16	2.4 ± 1.0	NB
P	*Bartonia paniculata ssp. iodandra*	Branched Bartonia				S3	16	69.4 ± 0.0	NB
P	*Gentianella amarella ssp. acuta*	Northern Gentian				S3	11	32.4 ± 0.0	NB
P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	17	41.6 ± 5.0	NB
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S3	35	18.9 ± 5.0	NB
P	*Myriophyllum humile*	Low Water Milfoil				S3	16	31.7 ± 1.0	NB
P	*Myriophyllum quitense*	Andean Water Milfoil				S3	71	79.1 ± 0.0	NB

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P	*Proserpinaca palustris*	Marsh Mermaidweed				S3	51	31.1 ± 0.0	NB
P	*Utricularia resupinata*	Inverted Bladderwort				S3	16	51.1 ± 0.0	NB
P	*Fraxinus pennsylvanica*	Red Ash				S3	166	2.5 ± 0.0	NB
P	*Rumex pallidus*	Seabeach Dock				S3	5	60.2 ± 1.0	NB
P	*Rumex occidentalis*	Western Dock				S3	1	16.6 ± 1.0	NB
P	*Podostemum ceratophyllum*	Horn-leaved Riverweed				S3	48	34.4 ± 0.0	NB
P	*Primula mistassinica*	Mistassini Primrose				S3	22	0.1 ± 1.0	NB
P	*Pyrola minor*	Lesser Pyrola				S3	2	63.0 ± 0.0	NB
P	*Anemone multifida*	Cut-leaved Anemone				S3	5	0.9 ± 0.0	NB
P	*Anemone multifida var. multifida*	Early Anemone				S3	2	65.9 ± 5.0	NB
P	*Clematis occidentalis*	Purple Clematis				S3	37	3.0 ± 1.0	NB
P	*Ranunculus flabellaris*	Yellow Water Buttercup				S3	24	20.1 ± 0.0	NB
P	*Amelanchier gaspensis*	Gasp├⌐ Serviceberry				S3	1	61.8 ± 0.0	NB
P	*Amelanchier canadensis*	Canada Serviceberry				S3	19	17.2 ± 0.0	NB
P	*Crataegus scabrida*	Rough Hawthorn				S3	9	58.0 ± 1.0	NB
P	*Rubus occidentalis*	Black Raspberry				S3	154	1.3 ± 0.0	NB
P	*Salix candida*	Sage Willow				S3	12	14.5 ± 1.0	NB
P	*Salix myricoides*	Bayberry Willow				S3	16	4.4 ± 0.0	NB
P	*Salix nigra*	Black Willow				S3	182	4.6 ± 1.0	NB
P	*Salix interior*	Sandbar Willow				S3	48	1.2 ± 1.0	NB
P	*Comandra umbellata*	Bastard's Toadflax				S3	2	62.1 ± 10.0	NB
P	*Agalinis purpurea var. parviflora*	Small-flowered Purple False Foxglove				S3	11	13.7 ± 0.0	NB
P	*Castilleja septentrionalis*	Northeastern Paintbrush				S3	9	63.3 ± 0.0	NB
P	*Valeriana uliginosa*	Swamp Valerian				S3	57	45.4 ± 0.0	NB
P	*Viola adunca*	Hooked Violet				S3	11	44.4 ± 1.0	NB
P	*Symplocarpus foetidus*	Eastern Skunk Cabbage				S3	79	30.0 ± 0.0	NB
P	*Carex adusta*	Lesser Brown Sedge				S3	11	42.7 ± 10.0	NB
P	*Carex arcta*	Northern Clustered Sedge				S3	63	29.9 ± 0.0	NB
P	*Carex conoidea*	Field Sedge				S3	24	2.3 ± 1.0	NB
P	*Carex garberi*	Garber's Sedge				S3	16	37.9 ± 0.0	NB
P	*Carex granularis*	Limestone Meadow Sedge				S3	8	1.3 ± 0.0	NB
P	*Carex gynocrates*	Northern Bog Sedge				S3	49	57.0 ± 0.0	NB
P	*Carex hirtifolia*	Pubescent Sedge				S3	78	3.0 ± 0.0	NB
P	*Carex livida*	Livid Sedge				S3	7	73.9 ± 0.0	NB
P	*Carex ormostachya*	Necklace Spike Sedge				S3	29	2.5 ± 1.0	NB
P	*Carex plantaginea*	Plantain-Leaved Sedge				S3	177	2.8 ± 0.0	NB
P	*Carex prairea*	Prairie Sedge				S3	35	70.7 ± 0.0	NB
P	*Carex rosea*	Rosy Sedge				S3	269	1.3 ± 0.0	NB
P	*Carex sprengelii*	Longbeak Sedge				S3	52	3.2 ± 0.0	NB
P	*Carex tenuiflora*	Sparse-Flowered Sedge				S3	36	54.9 ± 0.0	NB
P	*Carex vaginata*	Sheathed Sedge				S3	24	45.5 ± 0.0	NB
P	*Cyperus esculentus*	Perennial Yellow Nutsedge				S3	1	54.8 ± 0.0	NB
P	*Cyperus esculentus var. leptostachyus*	Perennial Yellow Nutsedge				S3	87	3.9 ± 0.0	NB
P	*Cyperus squarrosus*	Awned Flatsedge				S3	46	19.5 ± 0.0	NB
P	*Eriophorum gracile*	Slender Cottongrass				S3	16	50.0 ± 0.0	NB
P	*Blysmopsis rufa*	Red Bulrush				S3	1	93.4 ± 0.0	NB
P	*Elodea nuttallii*	Nuttall's Waterweed				S3	12	17.6 ± 5.0	NB
P	*Juncus brachycephalus*	Small-Head Rush				S3	7	50.6 ± 0.0	NB
P	*Juncus vaseyi*	Vasey Rush				S3	11	67.0 ± 0.0	NB
P	*Najas gracillima*	Thread-Like Naiad				S3	11	45.9 ± 0.0	NB
P	*Cypripedium reginae*	Showy Lady's-Slipper				S3	138	45.5 ± 0.0	NB
P	*Goodyera oblongifolia*	Menzies' Rattlesnake-plantain				S3	1	45.4 ± 0.0	NB
P	*Neottia auriculata*	Auricled Twayblade				S3	9	9.1 ± 0.0	NB
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	66	9.4 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3	36	15.6 ± 1.0	NB
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S3	25	24.8 ± 50.0	NB
P	*Agrostis mertensii*	Northern Bent Grass				S3	2	20.9 ± 0.0	NB
P	*Bromus latiglumis*	Broad-Glumed Brome				S3	31	1.6 ± 0.0	NB
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	14	2.2 ± 0.0	NB
P	*Leersia virginica*	White Cut Grass				S3	42	4.9 ± 1.0	NB
P	*Muhlenbergia richardsonis*	Mat Muhly				S3	34	1.8 ± 0.0	NB
P	*Schizachyrium scoparium*	Little Bluestem				S3	63	0.1 ± 1.0	NB
P	*Zizania aquatica*	Southern Wild Rice				S3	2	55.4 ± 0.0	NB
P	*Zizania aquatica var. aquatica*	Eastern Wild Rice				S3	6	17.3 ± 5.0	NB
P	*Adiantum pedatum*	Northern Maidenhair Fern				S3	475	3.2 ± 5.0	NB
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S3	9	12.0 ± 0.0	NB
P	*Anchistea virginica*	Virginia chain fern				S3	43	12.3 ± 0.0	NB
P	*Dryopteris goldieana*	Goldie's Woodfern				S3	309	4.4 ± 0.0	NB
P	*Woodsia alpina*	Alpine Cliff Fern				S3	6	89.8 ± 1.0	NB
P	*Isoetes tuckermanii ssp. tuckermanii*	Tuckerman's Quillwort				S3	20	24.2 ± 0.0	NB
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3	15	20.3 ± 0.0	NB
P	*Huperzia appressa*	Mountain Firmoss				S3	1	97.0 ± 1.0	NB
P	*Sceptridium dissectum*	Dissected Moonwort				S3	55	14.4 ± 0.0	NB
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S3	26	9.4 ± 0.0	NB
P	*Botrychium simplex*	Least Moonwort				S3	15	9.4 ± 0.0	NB
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S3	9	46.1 ± 1.0	NB
P	*Selaginella selaginoides*	Low Spikemoss				S3	4	90.0 ± 6.0	NB
P	*Crataegus submollis*	Quebec Hawthorn				S3?	19	5.5 ± 1.0	NB
P	*Crataegus succulenta*	Fleshy Hawthorn				S3?	1	17.3 ± 5.0	NB
P	*Platanthera hookeri*	Hooker's Orchid				S3?	48	11.0 ± 1.0	NB
P	*Arnica lanceolata*	Lance-leaved Arnica				S3S4	27	36.6 ± 0.0	NB
P	*Bidens hyperborea*	Estuary Beggarticks				S3S4	1	93.4 ± 0.0	NB
P	*Solidago altissima*	Tall Goldenrod				S3S4	48	4.4 ± 0.0	NB
P	*Symphyotrichum boreale*	Boreal Aster				S3S4	166	5.5 ± 10.0	NB
P	*Betula pumila*	Bog Birch				S3S4	46	30.7 ± 0.0	NB
P	*Mertensia maritima*	Sea Lungwort				S3S4	11	93.4 ± 0.0	NB
P	*Subularia aquatica ssp. americana*	American Water Awlwort				S3S4	18	27.5 ± 0.0	NB
P	*Lobelia cardinalis*	Cardinal Flower				S3S4	412	20.3 ± 1.0	NB
P	*Callitriche hermaphroditica*	Northern Water-starwort				S3S4	7	64.2 ± 0.0	NB
P	*Viburnum edule*	Squashberry				S3S4	13	26.2 ± 1.0	NB
P	*Crassula aquatica*	Water Pygmyweed				S3S4	3	46.6 ± 1.0	NB
P	*Penthorum sedoides*	Ditch Stonecrop				S3S4	86	4.2 ± 0.0	NB
P	*Elatine americana*	American Waterwort				S3S4	8	46.7 ± 1.0	NB
P	*Hedysarum americanum*	Alpine Hedysarum				S3S4	36	61.3 ± 0.0	NB
P	*Fagus grandifolia*	American Beech				S3S4	395	1.1 ± 0.0	NB
P	*Geranium robertianum*	Herb Robert				S3S4	23	88.0 ± 1.0	NB
P	*Stachys hispida*	Smooth Hedge-Nettle				S3S4	17	1.2 ± 0.0	NB
P	*Stachys pilosa*	Hairy Hedge-Nettle				S3S4	7	4.4 ± 0.0	NB
P	*Utricularia radiata*	Little Floating Bladderwort				S3S4	96	46.7 ± 0.0	NB
P	*Utricularia gibba*	Humped Bladderwort				S3S4	40	20.2 ± 0.0	NB
P	*Fraxinus americana*	White Ash				S3S4	357	1.1 ± 0.0	NB
P	*Epilobium strictum*	Downy Willowherb				S3S4	69	2.4 ± 1.0	NB
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	43	3.7 ± 1.0	NB
P	*Littorella americana*	American Shoreweed				S3S4	41	28.0 ± 0.0	NB
P	*Thalictrum confine*	Northern Meadow-rue				S3S4	114	0.3 ± 1.0	NB
P	*Drymocallis arguta*	Tall Wood Beauty				S3S4	57	1.3 ± 1.0	NB
P	*Rosa palustris*	Swamp Rose				S3S4	183	27.9 ± 0.0	NB
P	*Rubus pensilvanicus*	Pennsylvania Blackberry				S3S4	17	16.6 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Galium boreale*	Northern Bedstraw				S3S4	17	8.4 ± 0.0	NB
P	*Galium labradoricum*	Labrador Bedstraw				S3S4	123	51.6 ± 0.0	NB
P	*Salix pedicellaris*	Bog Willow				S3S4	98	30.8 ± 3.0	NB
P	*Geocaulon lividum*	Northern Comandra				S3S4	8	62.9 ± 0.0	NB
P	*Parnassia glauca*	Fen Grass-of-Parnassus				S3S4	13	9.1 ± 10.0	NB
P	*Agalinis neoscotica*	Nova Scotia Agalinis				S3S4	8	14.8 ± 0.0	NB
P	*Limosella australis*	Southern Mudwort				S3S4	1	90.7 ± 5.0	NB
P	*Ulmus americana*	White Elm				S3S4	292	2.5 ± 1.0	NB
P	*Boehmeria cylindrica*	Small-spike False-nettle				S3S4	171	6.0 ± 0.0	NB
P	*Juniperus horizontalis*	Creeping Juniper				S3S4	1	93.4 ± 0.0	NB
P	*Carex capillaris*	Hairlike Sedge				S3S4	14	68.6 ± 0.0	NB
P	*Carex eburnea*	Bristle-leaved Sedge				S3S4	10	63.9 ± 1.0	NB
P	*Carex exilis*	Coastal Sedge				S3S4	112	51.1 ± 0.0	NB
P	*Carex haydenii*	Hayden's Sedge				S3S4	105	5.5 ± 0.0	NB
P	*Carex lupulina*	Hop Sedge				S3S4	136	5.5 ± 0.0	NB
P	*Carex tenera*	Tender Sedge				S3S4	82	1.8 ± 1.0	NB
P	*Carex wiegandii*	Wiegand's Sedge				S3S4	67	37.5 ± 0.0	NB
P	*Carex recta*	Estuary Sedge				S3S4	4	58.3 ± 0.0	NB
P	*Carex atratiformis*	Scabrous Black Sedge				S3S4	5	74.4 ± 0.0	NB
P	*Cladium mariscoides*	Smooth Twigrush				S3S4	126	9.4 ± 0.0	NB
P	*Cyperus dentatus*	Toothed Flatsedge				S3S4	243	5.7 ± 0.0	NB
P	*Eleocharis quinqueflora*	Few-flowered Spikerush				S3S4	36	6.0 ± 0.0	NB
P	*Rhynchospora capitellata*	Small-headed Beakrush				S3S4	53	34.9 ± 0.0	NB
P	*Trichophorum clintonii*	Clinton's Clubrush				S3S4	114	39.4 ± 1.0	NB
P	*Bolboschoenus fluviatilis*	River Bulrush				S3S4	59	36.0 ± 0.0	NB
P	*Triglochin gaspensis*	Gasp├⌐ Arrowgrass				S3S4	9	88.7 ± 1.0	NB
P	*Lilium canadense*	Canada Lily				S3S4	178	8.9 ± 0.0	NB
P	*Triantha glutinosa*	Sticky False-Asphodel				S3S4	89	2.4 ± 1.0	NB
P	*Corallorhiza maculata*	Spotted Coralroot				S3S4	20	12.0 ± 0.0	NB
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	30	1.4 ± 1.0	NB
P	*Neottia cordata*	Heart-leaved Twayblade				S3S4	42	29.8 ± 2.0	NB
P	*Platanthera obtusata*	Blunt-leaved Orchid				S3S4	44	43.2 ± 6.0	NB
P	*Calamagrostis pickeringii*	Pickering's Reed Grass				S3S4	111	65.3 ± 0.0	NB
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S3S4	3	77.8 ± 0.0	NB
P	*Eragrostis pectinacea*	Tufted Love Grass				S3S4	16	5.0 ± 1.0	NB
P	*Stuckenia filiformis*	Thread-leaved Pondweed				S3S4	12	65.5 ± 0.0	NB
P	*Potamogeton praelongus*	White-stemmed Pondweed				S3S4	24	39.2 ± 0.0	NB
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3S4	42	18.0 ± 5.0	NB
P	*Xyris montana*	Northern Yellow-Eyed-Grass				S3S4	30	34.8 ± 0.0	NB
P	*Cryptogramma stelleri*	Steller's Rockbrake				S3S4	1	93.4 ± 0.0	NB
P	*Asplenium viride*	Green Spleenwort				S3S4	15	79.6 ± 0.0	NB
P	*Dryopteris fragrans*	Fragrant Wood Fern				S3S4	21	39.7 ± 0.0	NB
P	*Equisetum palustre*	Marsh Horsetail				S3S4	14	4.6 ± 0.0	NB
P	*Polypodium appalachianum*	Appalachian Polypody				S3S4	50	11.8 ± 1.0	NB
P	*Solidago caesia*	Blue-stemmed Goldenrod				SX	2	99.7 ± 1.0	NB
P	*Solidago ptarmicoides*	Upland White Goldenrod				SX	3	58.8 ± 1.0	NB
P	*Celastrus scandens*	Climbing Bittersweet				SX	4	2.4 ± 1.0	NB

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The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

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4	Bredin, K.A. 2003. NB Freshwater Mussel Fieldwork. Atlantic Canada Conservation Data Centere, 20 recs.
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2	Doucet, D.A. 2007. Lepidopteran Records, 1988-2006. Doucet, 700 recs.
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1	Boyne, A.W. 2000. Harlequin Duck Surveys. Canadian Wildlife Service, Sackville, unpublished data. 5 recs.
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1	Brunelle, P.-M. (compiler). 2010. ADIP/MDDS Odonata Database: NB, NS Update 1900-09. Atlantic Dragonfly Inventory Program (ADIP), 935 recs.
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1	Forbes, G.J. 2020. Email regarding a Snapping Turtle (Chelydra serpentina) occurrence in New Brunswick, from Graham Forbes to John Klymko. pers. comm, 1 record.
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1	Goltz, J.P. 2020. Email to Sean Blaney regarding Anchistea virginica (Virginia Chain-fern) at Magaguadavic Lake, NB. pers. comm., 1 record.
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1	Parkinson, K. 2017. Wood Turtle record in the Meduxnekeag Valley Nature Preserve. Pers. comm. to AC CDC.
1	Sabine, D.L. & Goltz, J.P. 2006. Discovery of Utricularia resupinata at Little Otter Lake, CFB Gagetown. Pers. comm. to D.M. Mazerolle, 1 rec.
1	Sabine, D.L. 2004. Specimen data: Whittaker Lake & Marysville NB. Pers. comm. to C.S. Blaney, 2pp, 4 recs.
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1	Taylor, Eric B. 1997. Status of the Sympatric Smelt (genus Osmerus) Populations of Lake Utopia, New Brunswick. Committee on the Status of Endangered Wildlife in Canada, 1 rec.
1	Toner, M. 2005. Listera australis population at Bull Pasture Plains. NB Dept of Natural Resources. Pers. comm. to S. Blaney, 8 recs.
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1	Torenvliet, Ed. 2010. Wood Turtle roadkill. NB Dept of Transport. Pers. com. to R. Lautenschlager, Aug. 20, photos, 1 rec.
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APPENDIX 7.B

Vascular Plant Species Observed

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Abies balsamea	Balsam fir	S5
Acer negundo	Manitoba maple	SNA
Acer platanoides	Norway maple	SNA
Acer rubrum	Red maple	S5
Acer saccharinum	Silver maple	S4
Acer saccharum	Sugar maple	S5
Acer spicatum	Mountain maple	S5
Actaea pachypoda	White baneberry	S4
Actaea rubra	Red baneberry	S5
Aegopodium podagraria	Goutweed	SNA
Ageratina altissima	White snakeroot	S4S5
Agrimonia gryposepala	Hooked agrimony	S4
Agrimonia striata	Woodland agrimony	S5
Agrostis capillaris	Colonial bent grass	SNA
Agrostis gigantea	Redtop	SNA
Agrostis perennans	Upland bent grass	S5
Agrostis stolonifera	Creeping bent grass	S5
Alnus alnobetula	Green alder	S5
Alnus incana	Speckled alder	S5
Ambrosia artemisiifolia	Common ragweed	S5
Amelanchier sp.	Serviceberry	-[2]
Amphicarpaea bracteata	American hog peanut	S4S5
Anaphalis margaritacea	Pearly everlasting	S5
Anemonastrum canadense	Canada anemone	S5
Anemone virginiana	Virginia anemone	S4
Angelica sylvestris	Woodland angelica	SNA
Antennaria howellii	Howell's pussytoes	S5
Anthoxanthum odoratum	Large sweet vernal grass	SNA
Apios americana	American groundnut	S4S5
Apocynum androsaemifolium	Spreading dogbane	S5
Apocynum cannabinum	Indian hemp	S4
Aquilegia vulgaris	European columbine	SNA
Aralia nudicaulis	Wild sarsaparilla	S5
Arctium lappa	Great burdock	SNA
Arctium minus	Common burdock	SNA

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Arctium tomentosum	Woolly burdock	SNA
Arisaema triphyllum	Jack-in-the-pulpit	S5
Artemisia absinthium	Absinth wormwood	SNA
Artemisia vulgaris	Common wormwood	SNA
Asclepias syriaca	Common milkweed	S4S5
Asparagus officinalis	Garden asparagus	SNA
Athyrium filix-femina	Common lady fern	S5
Barbarea vulgaris	Yellow rocket	SNA
Betula alleghaniensis	Yellow birch	S5
Betula papyrifera	Paper birch	S5
Betula populifolia	Gray birch	S5
Bidens frondosa	Devil's beggarticks	S5
Bromus ciliatus	Fringed brome	S5
Bromus inermis	Smooth brome	SNA
***Bromus latiglumis*[3]**	**Broad-glumed brome**	**S3**
Calamagrostis canadensis	Bluejoint reed grass	S5
Calystegia sepium	Hedge false bindweed	S5
Campanula intercedens	Common harebell	S5
Carex bebbii	Bebb's sedge	S4
Carex crawfordii	Crawford's sedge	S5
Carex cumulata	Dense sedge	S4S5
Carex debilis	White-edged Sedge	S5
Carex gracillima	Graceful sedge	S5
Carex granularis	**Limestone meadow sedge**	**S3**
Carex gynandra	Nodding sedge	S5
Carex houghtoniana	Houghton's sedge	S4
Carex lurida	Sallow sedge	S5
Carex panicea	Grasslike sedge	SNA
Carex radiata	Eastern star sedge	S4
Carex rosea	**Rosy sedge**	**S3**
Carex scabrata	Rough sedge	S5
Carex scoparia	Broom sedge	S5
Carex tenera	Tender sedge	S3S4
Carex vulpinoidea	Fox sedge	S4S5
Chaenorhinum minus	Dwarf snapdragon	SNA

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Chamaenerion angustifolium	Fireweed	S5
Cichorium intybus	Wild chicory	SNA
Cicuta maculata	Spotted water-hemlock	S5
Cinna latifolia	Drooping wood reed grass	S5
Circaea alpina	Small enchanter's nightshade	S5
Circaea canadensis	Broad-leaved enchanter's nightshade	S4
Cirsium arvense	Canada thistle	SNA
Cirsium muticum	Swamp thistle	S5
Cirsium vulgare	Bull thistle	SNA
Claytosmunda claytoniana	Interrupted fern	S5
Clematis virginiana	Virginia clematis	S5
Cornus alternifolia	Alternate-leaved dogwood	S5
Cornus canadensis	Bunchberry	S5
Cornus rugosa	Round-leaved dogwood	S4
Cornus sericea	Red osier dogwood	S5
Corylus cornuta	Beaked hazel	S5
Crataegus sp.	A Hawthorn	-
Crepis tectorum	Narrow-leaved hawksbeard	SNA
Dactylis glomerata	Orchard grass	SNA
Danthonia spicata	Poverty oat grass	S5
Desmodium canadense	Canada tick-trefoil	S4S5
Dichanthelium acuminatum	Woolly panic grass	SNA
Diervilla lonicera	Northern bush honeysuckle	S5
Doellingeria umbellata	Hairy flat-top white aster	S5
Dryopteris carthusiana	Spinulose wood fern	S5
Dryopteris cristata	Crested wood fern	S5
Dryopteris intermedia	Evergreen wood fern	S5
Dryopteris marginalis	Marginal wood fern	S5
Echinochloa crus-galli	Large barnyard grass	SNA
Echinocystis lobata	Wild cucumber	S5
Eleocharis sp.	A Spikerush	-
Elodea canadensis	Canada waterweed	S4S5
Elymus canadensis	**Canada wild rye**	**S2S3**
Elymus repens	Quack grass	SNA
Elymus trachycaulus	Slender wild rye	S4S5

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Elymus virginicus	Virginia wild rye	S5
Epilobium ciliatum	Northern willowherb	S5
Epipactis helleborine	Helleborine	SNA
Equisetum arvense	Field horsetail	S5
Equisetum fluviatile	Water horsetail	S5
Erechtites hieraciifolius	Eastern burnweed	S5
Erigeron annuus	Annual fleabane	S4S5
Erigeron canadensis	Canada horseweed	S5
Erigeron strigosus	Rough fleabane	S5
Erysimum cheiranthoides	Worm-seeded wallflower	S5
Eupatorium perfoliatum	Common boneset	S5
Euphrasia stricta	Stiff eyebright	SNA
Eurybia macrophylla	Large-leaved aster	S5
Euthamia graminifolia	Grass-leaved goldenrod	S5
Eutrochium maculatum	Spotted Joe-pye-weed	S5
Fagus grandifolia	American beech	S3S4
Festuca rubra	Red fescue	S5
Fragaria vesca	Woodland strawberry	S4
Fragaria virginiana	Wild strawberry	S5
Frangula alnus	Glossy buckthorn	SNA
Fraxinus americana	White ash	S3S4
Fraxinus nigra	**Black ash**	**S3S4**
Fraxinus pennsylvanica	**Red Ash**	**S3**
Galeopsis tetrahit	Common hemp-nettle	SNA
Galium mollugo	Smooth bedstraw	SNA
Galium verum	Yellow bedstraw	SNA
Geum aleppicum	Yellow avens	S5
Geum canadense	White avens	S5
Geum macrophyllum	Large-leaved avens	S5
Glechoma hederacea	Ground ivy	SNA
Glyceria grandis	Common tall manna grass	S5
Glyceria striata	Fowl manna grass	S5
Gnaphalium uliginosum	Marsh cudweed	SNA
Gymnocarpium dryopteris	Common oak fern	S5
Hieracium lachenalii	Common hawkweed	SNA

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Hieracium murorum	Wall hawkweed	SNA
Hieracium umbellatum	Umbellate hawkweed	S5
Hylotelephium telephium	Garden stonecrop	SNA
Hypericum perforatum	Common St. John's-wort	SNA
Impatiens capensis	Spotted jewelweed	S5
Iris versicolor	Harlequin blue flag	S5
Juglans cinerea	**Butternut**	**S1**
Juncus alpinoarticulatus	Alpine rush	S4
Juncus brevicaudatus	Short-tailed rush	S5
Juncus nodosus	Knotted rush	S4S5
Juncus tenuis	Path rush	S5
Lactuca canadensis	Canada lettuce	S5
Lathyrus pratensis	Meadow vetchling	SNA
Leersia oryzoides	Rice cut grass	S5
Leucanthemum vulgare	Oxeye daisy	SNA
Linaria vulgaris	Butter-and-eggs	SNA
Lolium pratense	Meadow fescue	SNA
Lonicera canadensis	Canada fly honeysuckle	S5
Lonicera morrowii	Morrow's honeysuckle	SNA
Lonicera tatarica	Tartarian honeysuckle	SNA
Lonicera x bella	A Hybrid honeysuckle	SNA
Lotus corniculatus	Garden bird's-foot trefoil	SNA
Ludwigia palustris	Marsh seedbox	S4
Luzula multiflora	Common woodrush	S5
Lycopus americanus	American water horehound	S5
Lysimachia ciliata	Fringed yellow loosestrife	S5
Lysimachia nummularia	Creeping yellow loosestrife	SNA
Lythrum salicaria	Purple loosestrife	SNA
Maianthemum canadense	Wild lily-of-the-valley	S5
Maianthemum racemosum	Large false solomon's seal	S5
Malus pumila	Common apple	SNA
Matricaria discoidea	Pineapple weed	SNA
Matteuccia struthiopteris	Ostrich fern	S5
Melilotus albus	White sweet-clover	SNA
Mentha arvensis	Wild mint	SNA

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Mimulus ringens	Square-stemmed monkeyflower	S5
Muhlenbergia frondosa	Wire-stemmed muhly	S4
Myosotis laxa	Small forget-me-not	S5
Myosotis scorpioides	True forget-me-not	SNA
Myrica gale	Sweet gale	S5
Myriophyllum sp.	A Water-milfoil	#N/A
Nabalus altissimus	Tall rattlesnakeroot	S5
Nabalus trifoliolatus	Three-leaved rattlesnakeroot	S5
Oenothera biennis	Common evening primrose	S5
Onoclea sensibilis	Sensitive fern	S5
Ostrya virginiana	Ironwood	S4S5
Oxalis stricta	European wood sorrel	S5
Panicum capillare	Common witch grass	S5
Parathelypteris noveboracensis	New York fern	S5
Parthenocissus quinquefolia	Virginia creeper	SNA
Pastinaca sativa	Wild parsnip	SNA
Persicaria amphibia	Water smartweed	S5
Persicaria sagittata	Arrow-leaved smartweed	S5
Phalaris arundinacea	Reed canary grass	S5
Phegopteris connectilis	Northern beech fern	S5
Phleum pratense	Common timothy	SNA
Picea glauca	White spruce	S5
Pilosella aurantiaca	Orange hawkweed	SNA
Pilosella officinarum	Mouse-ear Hawkweed	SNA
Pimpinella saxifraga	Burnet saxifrage	SNA
Pinus strobus	Eastern white pine	S5
Plantago lanceolata	English plantain	SNA
Plantago major	Common plantain	SNA
Poa annua	Annual blue grass	SNA
Poa compressa	Canada blue grass	SNA
Poa palustris	Fowl blue grass	S5
Poa pratensis	Kentucky blue grass	S5
Populus balsamifera	Balsam poplar	S5
Populus grandidentata	Large-toothed aspen	S5
Populus tremuloides	Trembling aspen	S5

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Potamogeton perfoliatus	Clasping-leaved pondweed	S4S5
Potamogeton richardsonii	Richardson's pondweed	S3S4
Potentilla anserina	Common silverweed	S5
Potentilla norvegica	Rough cinquefoil	S5
Potentilla simplex	Old field cinquefoil	S5
Prunella vulgaris	Common self-heal	S5
Prunus pensylvanica	Pin cherry	S5
Prunus serotina	Black cherry	S5
Prunus virginiana	Chokecherry	S5
Pteridium aquilinum	Bracken fern	S5
Puccinellia distans	Spreading alkali grass	SNA
Quercus rubra	Northern red oak	S5
Ranunculus acris	Common buttercup	SNA
Ranunculus flammula	Lesser spearwort	S5
Ranunculus recurvatus	Hooked buttercup	S4
Ranunculus repens	Creeping buttercup	SNA
Rhinanthus minor	Little yellow rattle	SNA
Rhus typhina	Staghorn sumac	S5
Ribes americanum	Wild black currant	S4
Ribes nigrum	European black currant	SNA
Ribes triste	Swamp red currant	S5
Rorippa palustris	Bog yellowcress	S5
Rorippa sylvestris	Creeping yellowcress	SNA
Rosa blanda	Smooth rose	S5
Rosa multiflora	Multiflora rose	SNA
Rubus allegheniensis	Allegheny blackberry	S5
Rubus canadensis	Smooth blackberry	S5
Rubus idaeus	Red raspberry	S5
Rubus occidentalis	**Black raspberry**	**S3**
Rubus pubescens	Dwarf red raspberry	S5
Rubus x crux	Ashe's blackberry	S4S5
Rudbeckia hirta	Black-eyed susan	SNA
Rumex crispus	Curled dock	SNA
Rumex obtusifolius	Bitter dock	SNA
Sagittaria sp.	An Arrowhead	-

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Salix alba	White willow	SNA
Salix bebbiana	Bebb's willow	S5
Salix discolor	Pussy willow	S5
Salix eriocephala	Cottony willow	S5
Salix humilis	Upland willow	S5
Salix lucida	Shining willow	S5
Salix sericea	Silky willow	S5
Sambucus canadensis	Common elderberry	S5
Sambucus racemosa	Red elderberry	S5
Scirpus atrocinctus	Black-girdled bulrush	S5
Scirpus cyperinus	Common woolly bulrush	S5
Scirpus hattorianus	Mosquito bulrush	S5
Scirpus microcarpus	Small-fruited bulrush	S5
Scorzoneroides autumnalis	Autumn hawkbit	SNA
Scutellaria galericulata	Marsh skullcap	S5
Securigera varia	Purple crown-vetch	SNA
Senecio viscosus	Sticky ragwort	SNA
Setaria pumila	Low foxtail	SNA
Setaria viridis	Green foxtail	SNA
Silene vulgaris	Bladder campion	SNA
Sium suave	Common water parsnip	S5
Smilax herbacea	Herbaceous carrion flower	S4
Solanum dulcamara	Bittersweet nightshade	SNA
Solidago canadensis	Canada goldenrod	S5
Solidago flexicaulis	Zigzag goldenrod	S5
Solidago gigantea	Giant goldenrod	S5
Solidago juncea	Early goldenrod	S5
Solidago macrophylla	Large-leaved goldenrod	S4
Solidago puberula	Downy goldenrod	S5
Solidago rugosa	Rough-stemmed goldenrod	S5
Sonchus arvensis	Field sow thistle	SNA
Sonchus asper	Prickly sow thistle	SNA
Sorbaria sorbifolia	False spiraea	SNA
Sorbus americana	American mountain ash	S5
Sparganium angustifolium	Narrow-leaved burreed	S5

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Spergularia canadensis	Canada sandspurrey	S4
Spiraea alba	White meadowsweet	S5
Sporobolus michauxianus	Prairie cord grass	S5
Stachys hispida	Smooth hedge-nettle	S3S4
Stachys palustris	Marsh hedge-nettle	SNA
Stellaria graminea	Little starwort	SNA
Symphyotrichum ciliolatum	Fringed blue aster	S5
Symphyotrichum lanceolatum	Lance-leaved aster	S5
Symphyotrichum lateriflorum	Calico aster	S5
Symphyotrichum novi-belgii	New York aster	S5
Symphyotrichum puniceum	Purple-stemmed aster	S5
Tanacetum vulgare	Common tansy	SNA
Taraxacum officinale	Common dandelion	SNA
Taxus canadensis	Canada yew	S5
Thalictrum confine	Northern meadow-rue	S3S4
Thalictrum pubescens	Tall meadow-rue	S5
Thuja occidentalis	Eastern white cedar	S5
Tiarella cordifolia	Heart-leaved foamflower	S4S5
Tilia americana	White basswood	S4
Toxicodendron radicans	Poison ivy	S5
Tragopogon pratensis	Meadow goatsbeard	SNA
Trifolium aureum	Yellow clover	SNA
Trifolium campestre	Low hop clover	SNA
Trifolium hybridum	Alsike clover	SNA
Trifolium pratense	Red clover	SNA
Trifolium repens	White clover	SNA
Trillium cernuum	Nodding trillium	S5
Trillium erectum	Red trillium	S5
Tsuga canadensis	Eastern hemlock	S5
Tussilago farfara	Coltsfoot	SNA
Typha latifolia	Broad-leaved cattail	S5
Ulmus americana	White elm	S3S4
Urtica dioica	Stinging nettle	S4
Utricularia vulgaris ssp. macrorhiza	Greater bladderwort	S5
Verbascum thapsus	Common mullein	SNA

Table 7B.1 Vascular Plant Species Observed within the Project Survey Area

Scientific Name	Common Name	AC CDC S-Rank[1]
Verbena hastata	Blue vervain	S4
Verbena urticifolia	**White vervain**	**S2S3**
Veronica officinalis	Common speedwell	SNA
Viburnum lantanoides	Hobblebush	S5
Viburnum opulus	Highbush cranberry	S4
Vicia cracca	Tufted vetch	SNA
Viola sp.	A Violet	-
Vitis riparia	Riverbank grape	S4

Notes:

[1] S1 = Critically Imperiled, S2 = Imperiled, S3 = Vulnerable, S4 = Apparently Secure, S5 = Secure, SNA = Not Applicable (AC CDC 2022a)
[2] Some specimens were identified to genus level. No S ranks are provided for genera.
[3] Bolded species are SOCC, with the exception of butternut and black ash, which are SAR. See Table 7.2 for an explanation of their SAR designations.

8.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON WILDLIFE AND WILDLIFE HABITAT

This chapter assesses the potential environmental interactions between the construction, and operation and maintenance phases of the Project and the wildlife and wildlife habitat valued component (VC).

8.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

Wildlife and wildlife habitat was included as a VC due to its environmental, cultural, and social importance, and for the potential for the Project to interact with wildlife and wildlife habitat in the Project development area (PDA) and local assessment area (LAA). Wildlife and wildlife habitat are an important component of the environment as they provide ecological, aesthetic, recreational, economic, and cultural value to stakeholders, the public, Indigenous communities, local businesses, and government agencies and contribute to biodiversity. This VC focuses on terrestrial wildlife, including birds, mammals (including bats), herptiles, and their habitats.

8.2 SCOPE OF ASSESSMENT FOR WILDLIFE AND WILDLIFE HABITAT

8.2.1 Regulatory Context

8.2.1.1 Federal

Migratory Birds Convention Act

The *Migratory Birds Convention Act* provides protection for migratory birds on federal, provincial, and private lands. Most migratory species that are native or naturally occurring in Canada are protected; species and species groups are further defined in Section 2 of the Act. These protections include a prohibition on depositing harmful substances in areas frequented by migratory birds, and a prohibition on disturbing, destroying, taking, or possessing migratory birds, their nests, and eggs.

Species at Risk Act

The federal *Species at Risk Act* (*SARA*) provides protection for species at risk (SAR) in Canada that are listed on Schedule 1 of *SARA* (Government of Canada 2022). The legislation provides a framework to facilitate recovery of species listed as Threatened, Endangered, or Extirpated and to prevent species listed as Special Concern from becoming Threatened or Endangered. *SARA* provides protection for both SAR and their critical habitat or residences by prohibiting: 1) the killing, harming, or harassing of Endangered or Threatened SAR (sections 32 and 36); 2) the destruction of critical habitat of an Endangered or Threatened SAR (sections 58, 60, and 61); and 3) damage or destruction of residence of SAR (section 33 of *SARA*). Residence descriptions, where defined, may afford additional protections to migratory birds that are not afforded under the *Migratory Bird Regulations*.

8.2.1.2 Provincial

Fish and Wildlife Act

The New Brunswick *Fish and Wildlife Act* provides general protection measures of wildlife, particularly as it relates to hunting and defines 'wildlife' as any vertebrate animal or bird that is usually wild by nature in New Brunswick.

New Brunswick *Species at Risk Act*

The New Brunswick *Species at Risk* Act (NB *SARA*) provides for the protection, designation, recovery, and other relevant aspects of conservation of SAR in New Brunswick, including habitat protection. NB *SARA* facilitates the conservation and management of wildlife species to prevent further declines and promote recovery.

8.2.2 Species at Risk and Species of Conservation Concern

For the purposes of this EIA registration, SAR include those listed as Extirpated, Endangered, Threatened, or Special Concern by the federal *SARA*, NB *SARA*, or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC assesses and designates the status of species and recommends this designation for legal protection under *SARA*.

Species of Conservation Concern (SOCC) are those species that do not meet the above definition of SAR, but are considered rare in New Brunswick, or the long-term sustainability of their populations has been evaluated as tenuous. SOCC are defined here as non-SAR species ranked S1 (Critically Imperiled), S2 (Imperiled), or S3 (Vulnerable) in New Brunswick by the Atlantic Canada Conservation Data Centre (AC CDC) (AC CDC 2022a) with the potential to occur in the LAA. SOCC are included in this VC as a precautionary measure, reflecting observations and trends in their provincial population status, and are often important indicators of ecosystem health and regional biodiversity.

While some species included as SAR in this assessment currently have regulatory protection as they are listed under Schedule 1 of the federal *SARA* or the *Prohibitions Regulation* of NB *SARA*, the definition above also includes those species on the NB *SARA List of Species at Risk Regulation* and those listed by COSEWIC that are candidates for further review and may become protected (covered by prohibitions) within the timeframe of this Project.

8.2.3 Spatial Boundaries

The assessment of potential environmental interactions between the Project and the wildlife and wildlife habitat is focused on a PDA and a LAA.

The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project (Figure 2.1).

The LAA for wildlife and wildlife habitat is the area within which measurable Project-related effects (direct or indirect) are expected to occur and is defined as a 1-kilometre (km) buffer around the PDA (Figure 8.1). The size of the buffer is based on measurable effects of noise on wildlife (*e.g.*, Benitez-Lopez *et al*. 2010, Shannon *et al*. 2016).

8.2.4 Temporal Boundaries

The temporal boundaries for the assessment of the potential interactions between the Project and wildlife and wildlife habitat include the following periods:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

Stantec

- Project Development Area
- Local Assessment Area
- Road
- Transmission Line
- Watercourse (DNR)
- Wetland (DELG)
- Kingsclear First Nation
- Provincial Park

0 200 400 metres
(At original document size of 8.5x11)
1:24,000

Notes

1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan,

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-11-23

Client/Project 121415886_016
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
8.1

Title
Spatial Boundaries for Wildlife and Wildlife Habitat

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8.3 EXISTING CONDITIONS FOR WILDLIFE AND WILDLIFE HABITAT

8.3.1 Methods

Existing conditions for wildlife were identified through a combination of desktop review and field surveys to better understand the occurrence, distribution, and habitat association of wildlife within the LAA, including for SAR and SOCC. This section provides a brief overview of the methods used to collect baseline data.

8.3.1.1 Desktop Review

Background information was obtained through several sources, including federal, provincial, and not-for-profit publications and data sources. Below is an overview of some of the key resources used during background reviews to assist in establishing the existing conditions for wildlife.

- Topographic mapping and orthographic aerial imagery were used to help identify habitat and provide an overall indication of site topography.
- *SARA* Public Registry is a database containing the status of species assessed and listed under the *SARA* and by COSEWIC, and associated documentation including assessment and status reports, recovery strategies, and management strategies (Government of Canada 2022).
- NB Species at Risk Public Registry is a database containing the status of species assessed by the province and listed under NB *SARA* (Government of New Brunswick 2022).
- The AC CDC maintains a database for biodiversity in Atlantic Canada, including SAR and SOCC observation data (AC CDC 2022a).
- Atlantic Canada Amphibian and Reptile Atlas is a citizen-science project documenting the distribution of amphibians in the Maritimes (iNaturalist 2022).
- North American Breeding Bird Survey (BBS) is an annual survey of breeding birds in North American used to monitor trends in species abundance and distribution (ECCC 2021).
- Maritimes Breeding Bird Atlas, a five-year (2006-2010) citizen-science project documenting the distribution of breeding birds in the Maritimes (MBBA 2022).
- Christmas Bird Count is North America's longest-running citizen science project (started in 1900) and includes an annual single-day survey of overwintering birds (Audubon 2021).
- Birds Canada is a database repository for several bird survey programs (Birds Canada 2022), including:
  - Atlantic Canada Nocturnal Owl Survey, a citizen-science project documenting the distribution of breeding owls in the Maritimes
  - eBird, a database of locational data for bird species in Canada
  - Canadian Nightjar Survey (CNS), a citizen-science project documenting the distribution of breeding nightjars (*i.e.*, Common Nighthawk [*Chordeiles minor*] and Eastern Whip-poor-will [*Antrostomus vociferus*]) in New Brunswick

8.3.1.2 Field Studies

Field studies were undertaken to help establish the existing condition for wildlife and wildlife habitat within the LAA, and included:

- Spring and fall bird movement surveys (2016)
- Breeding bird survey (2016)
- Owl and nightjar survey (2016)
- Remote cameras survey (mammals; 2016)
- Spring bird movement survey (2017)

Incidental detections of wildlife and wildlife sign were also recorded during field studies.

8.3.2 Results

8.3.2.1 Desktop Review

Terrestrial habitats within the PDA are highly disturbed by previous vegetation clearing and the presence of existing infrastructure and dam components, such as roads, parking lots, hydroelectric transmission lines, and the substation. Terrestrial habitat consists primarily of mowed lawns, exposed lands, planted coniferous trees, and small patches of mixed wood forest and deciduous shrubs, while riparian and aquatic habitat is limited to the St. John River. There is greater habitat availability for wildlife within the LAA, with larger patches of deciduous trees and shrubs and expanses of open water and associated riparian areas, but there remains a relatively high degree of anthropogenic disturbance (*e.g.,* roads, transmission lines, cleared lands) in the LAA. The LAA does not contain critical habitat for SAR and there are no known SARA-defined species residences within the LAA. The PDA contains the St. John River/Dam Environmentally Significant Area that has been established, in part, due to the high use of the area by waterfowl, Bald Eagle (*Haliaeetus leucocephalus*), and Osprey (*Pandion haliaetus*; AC CDC 2022a).

Results of the Maritimes Breeding Bird Atlas (square 19FL69 that overlaps the Project; MBBA 2022) indicate that 99 bird species have potential to occur within the LAA during the breeding season, with the most commonly detected species being Red-eyed Vireo (*Vireo olivaceus*), Song Sparrow (*Melospiza melodia*), American Crow (*Corvus corax*), and American Robin (*Turdus migratorius*; MBBA 2022). Results of the Christmas Bird Count indicate that 50 bird species overwinter within the Fredericton region; the most abundant native species (*i.e.,* excluding European Starling [*Sturnus vulgaris*] and Rock Pigeon [*Columba livia*]) are Black-capped Chickadee (*Poecile atricapillus*), American Crow, Canada Goose (*Branta canadensis*), and American Goldfinch (*Spinus tristis*; Audubon 2021).

The LAA has potential to provide habitat for 15 amphibian (nine toad and frog species and six salamander and newt species) and eight reptiles (four turtle and four snake species) species (AC CDC 2022a; iNaturalist 2022). The LAA may also support many species of terrestrial mammals (*e.g*., coyote [*Canas latrans*], snowshoe hare [*Lepus americanus*]) and aquatic or semi-aquatic mammals (*e.g.*, American beaver [*Castor canadensis*], muskrat [*Ondrata zibethicus*], American mink [*Neovision vision*]).

The LAA has potential to support 29 SAR (18 birds, 3 mammals, 2 reptiles, and 6 insects) and 30 SOCC (25 birds and 5 insects) which includes federally (*SARA*) and provincially (NB *SARA*) listed SAR whose ranges overlap the Project and SOCC with records within 5 km of the Project (AC CDC 2022a; Table 8.1). However, given the highly disturbed state of the PDA and LAA and the types of habitat present, only six species (*i.e.*, Bald Eagle, Common Nighthawk [*Chordeiles minor*], Barn Swallow [*Hirundo rustica*], Little Brown Myotis [*Myotis lucifugus*], Northern Myotis [*Myotis septentrionalis*], Tri-color Bat [*Perimyotis subflavus*]) are anticipated to have potential to interact with the Project given the results of the desktop review and field studies, and are described in greater detail in Section 8.3.3.

Table 8.1 SAR and SOCC with Potential to Occur within the LAA

Species		Status in Canada		Status in New Brunswick	
Common Name	**Scientific Name**	***SARA*[1]**	**COSEWIC[2]**	**NB *SARA*[3]**	**AC CDC[4]**
Birds					
Harlequin Duck*	*Histrionicus histrionicus*	SC	SC	EN	S1B,S1S2N, S2M
Bufflehead	*Bucephala albeola*	-	-	-	S3N
Barrow’s Goldeneye*	*Bucephala islandica*	SC	SC	SC	S2S3N,S3M
Red-breasted Merganser	*Mergus serrator*	-	-	-	S3B,S4S5N, S5M
Great Cormorant	*Phalacrocorax carbo*	-	-	-	S2N
Bald Eagle*	*Haliaeetus leucocephalus*	-	NAR	EN	S4
Cooper’s Hawk	*Accipiter cooperii*	-	NAR	-	S1S2B
Killdeer	*Charadrius vociferus*	-	-	-	S3B
Spotted Sandpiper	*Actitis macularius*	-	-	-	S3S4B,S4M
Solitary Sandpiper	*Tringa solitaria*	-	-	-	S2B,S4S5M
Ring-billed Gull	*Larus delawarensis*	-	-	-	S2S3B,S4N, S5M
Great Black-backed Gull	*Larus marinus*	-	-	-	S3
Horned Grebe*	*Podiceps auritus*	SC	SC	SC	S3N
Common Tern	*Sterna hirundo*	-	NAR	-	S3B,SUM
Short-eared Owl *	*Asio flammeus*	SC[◊]	TH	SC	S1S2B
Common Nighthawk*	*Chordeiles minor*	TH[◊]	SC	TH	S3B,S4M
Eastern Whip-poor-will*	*Caprimulgus vociferus*			TH	S2B
Chimney Swift*	*Chaetura pelagica*	TH	TH	TH	S2S3B,S2M
Black-Backed Woodpecker	*Picoides arcticus*	-	-	-	S3
Eastern Kingbird	*Tyrannus tyrannus*	-	-	-	S3S4B
Olive-sided Flycatcher*	*Contopus cooperi*	TH[◊]	SC	EN	S3B
Eastern Wood-pewee*	*Contopus virens*	SC	SC	SC	S3B
Great Crested Flycatcher	*Myiarchus crinitus*	-	-	-	S3B

Table 8.1 SAR and SOCC with Potential to Occur within the LAA

Species		Status in Canada		Status in New Brunswick	
Common Name	**Scientific Name**	***SARA*[1]**	**COSEWIC[2]**	**NB *SARA*[3]**	**AC CDC[4]**
Rusty Blackbird*	*Euphagus carolinus*	SC	SC	EN	S2S3B,S3M
Purple Martin	*Progne subis*	-	-	-	S1B
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	-	-	-	S1S2B
Bank Swallow*	*Riparia riparia*	TH	TH	TH	S2B
Cliff Swallow	*Petrochelidon pyrrhonota*	-	-	-	S2B
Barn Swallow*	*Hirundo rustica*	TH[◊]	SC	TH	S2B
House Wren	*Troglodytes aedon*	-	-	-	S1S2B
Wood Thrush*	*Hylocichla mustelina*	TH	TH	TH	S1S2B
Brown Thrasher	*Toxostoma rufum*	-	-	-	S2S3B
Warbling Vireo	*Vireo gilvus*	-	-	-	S3S4B
Cape May Warbler	*Setophaga tigrina*	-	-	-	S3B,S4S5M
Canada Warbler*	*Cardellina canadensis*	TH[◊]	SC	TH	S3S4B
Indigo Bunting	*Passerina cyanea*	-	-	-	S3B
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	-	-	-	S3B
Bobolink*	*Dolichonyx oryzivorus*	TH	SC	TH	S3B
Eastern Meadowlark*	*Sturnella magna*	TH	TH	TH	S1B
Brown-headed Cowbird	*Molothrus ater*	-	-	-	S3B
Baltimore Oriole	*Icterus galbula*	-	-	-	S2S3B
Evening Grosbeak*	*Coccothraustes vespertinus*	SC	SC	-	S3B, S3S4N,SUM
Scarlet Tanager	*Piranga olivacea*	-	-	-	S3B
Mammals					
Little brown myotis*	*Myotis lucifugus*	EN	EN	EN	S1
Northern myotis*	*Myotis septentrionalis*	EN	EN	EN	S2
Tri-colored bat*	*Perimyotis subflavus*	EN	EN	EN	S3
Reptiles					
Snapping turtle*	*Chelydra serpentina*	SC	SC	SC	S3
Wood turtle*	*Glyptemys insculpta*	TH	TH	TH	S2S3
Insects					
Monarch*	*Danaus plexippus*	SC[◊]	EN	EN	S2S3?B
Meadow fritillary	*Boloria bellona*	-	-	-	S3
Cobra clubtail	*Gomphurus vastus*	-	-	-	S3
Skillet clubtail*	*Gomphurus ventricosus*	EN	SC	EN	S2
Pygmy snaketail	*Ophiogomphus howei*	SC	SC	SC	S2S3

Table 8.1 SAR and SOCC with Potential to Occur within the LAA

Species		Status in Canada		Status in New Brunswick	
Common Name	**Scientific Name**	***SARA*[1]**	**COSEWIC[2]**	**NB *SARA*[3]**	**AC CDC[4]**
Cobblestone tiger beetle*	*Cicindela marginipennis*	SC◊	EN	EN	S2S3
Transverse lady beetle*	*Coccinella transvers-oguttata*	SC	SC	EN	SH
Gypsy cuckoo bumble bee*	*Bombus bohemicus*	EN	EN	EN	S1
Suckley's cuckoo bumble bee	*Bombus suckleyi*	NL◊	TH	-	SH
Yellow-banded bumble bee*	*Bombus terricola*	SC	SC	-	S4
Brown-belted bumble bee	*Bombus griseocollis*	-	-	-	S3S4

Notes:
* Indicates the species is considered a SAR; all others are SOCC.
[1] Species at risk in Canada listed under Schedule 1 the federal *Species at Risk Act* as Endangered (EN), Threatened (TH), or Special Concern (SC); species not listed = NL (Government of Canada 2022).
◊ Indicates species under consideration for status change.
[2] Species of conservation concern in Canada assessed by COSEWIC as Endangered (EN), Threatened (TH), or Special Concern (SC); not at risk species = NAR (Government of Canada 2022).
[3] Species at risk in New Brunswick listed under the provincial *Species at Risk Act* (NB) as Endangered (EN), Threatened (TH), or Special Concern (SC; Government of New Brunswick 2022).
[4] Species ranked as Critically Imperiled (S1), Imperiled (S2), or Vulnerable (S3) by the Atlantic Canada Conservation Data Centre (AC CDC 2022b) and recorded within 5 km of the Project by desktop data source, where:
S1: Critically Imperiled – Critically imperiled in the province because of extreme rarity (often 5 or fewer occurrences). May be especially vulnerable to extirpation.
S2: Imperiled – Imperiled in the province because of rarity due to very restricted range, very few populations (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3: Vulnerable – Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer).
S4: Apparently Secure – Uncommon but not rare; some cause for long-term concern due to declines or other factors (80+ occurrences).
S5: Secure – Common, widespread, and abundant in the province.
S#S#: A numeric range rank (*e.g.*, S2S3) is used to indicate any range of uncertainty about the status of the species or community.
SH: Possibly Extirpated (Historical) – Species or community occurred historically in the province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become SH without such a 20-40 year delay if the only known occurrences in a province were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
SU: Unrankable – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
B: Breeding – Conservation status refers to the breeding population of the species in the province.
N: Nonbreeding – Conservation status refers to the non-breeding population of the species in the province.
M: Migrant – Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the province.

8.3.2.2 Field Studies

Detections of SAR/SOCC during wildlife field studies were limited to Bald Eagle and Barn Swallow.

Breeding bird survey results indicate that the most commonly detected species were Song Sparrow, American Crow, American Goldfinch (*Spinus tristis*), and American Redstart (*Setophaga ruticilla*) and detections of SAR/SOCC were limited to Barn Swallow (see Section 8.3.3.3).

Bird movement survey results indicate that the most commonly detected species were Double-crested Cormorant (*Nannopterum auritum*), Ring-billed Gull (*Larus delawarensis*), Bald Eagle, and Common Merganser (*Mergus merganser*). Bald Eagle was the only SAR/SOCC detected during the survey and was detected frequently during field studies; while it regularly forages along the St. John River, it is unlikely to interact with the Project.

Results of the remote cameras survey indicate that the most commonly detected mammal species were white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), and groundhog (*Marmota monax*).

8.3.3 Species at Risk

The following provides information on the SAR that have been historically observed within 5 km of the PDA, as reported by the AC CDC (2022a).

8.3.3.1 Bald Eagle

Bald Eagle is listed as Endangered under NB *SARA* and has been federally assessed by COSEWIC as not at risk. Bald Eagle is a large raptor species that inhabits a variety of habitats adjacent to lakes and rivers that provide fishing opportunities. Habitat for the species within the PDA includes the St. John River and the species was regularly detected during field studies in 2016 and 2017; however, no nests were detected.

8.3.3.2 Common Nighthawk

Common Nighthawk is listed as Threatened under both the federal *SARA* and provincial NB *SARA*. Common Nighthawk is a medium-sized aerial insectivore that breeds in a variety of habitats, including forest clearings, burns, clearcuts, rocky outcrops, shorelines, and disturbed areas (COSEWIC 2007). Habitat for the species within the PDA is limited to disturbed areas (*e.g.*, rocky, exposed lands). Habitat within the LAA is more common where forest harvesting and other disturbed areas are more prevalent. The species was not detected during the species-specific survey in 2016, but breeding records exist within the region (Birds Canada 2022).

In 2016, a federal recovery strategy was developed that provides guidance aimed at halting and reversing population decline of Common Nighthawk, but existing data have been inadequate for determining critical habitat for Common Nighthawk (Environment Canada 2016).

8.3.3.3 Barn Swallow

Barn Swallow is listed as Threatened under both the federal *SARA* and provincial NB *SARA*; however, the species is under consideration for status change to Special Concern under *SARA*. Barn Swallow is a mid-sized aerial insectivore that forages in open habitats (*e.g.*, agricultural fields, shorelines) and nests on anthropogenic structures, particularly rural settlements and other structures (*e.g.*, culverts; COSEWIC 2011). Habitat for the species occurs throughout the PDA but nesting opportunities are limited to existing infrastructure. Five individuals were detected at a single location within the LAA during the 2016 breeding bird survey and breeding records exist within the region (Birds Canada 2022).

8.3.3.4 Myotis and Perimyotis Bats

Little myotis, northern myotis, and tri-colored bat are listed as Endangered under both the federal *SARA* and provincial NB *SARA*. Continental bat populations have experienced significant declines, primarily due to the spread of White-nose Syndrome (WNS), a fungal disease that affects hibernating bats and that has resulted in significantly increased mortality rates and has been detected in NB (COSEWIC 2013; WNSRT 2022).

All three species overwinter in cold and humid hibernacula (caves/mines), and large numbers of several species typically overwinter in relatively few hibernacula (COSEWIC 2013). In summer, females establish summer maternity colonies in large-diameter trees or in buildings. Foraging occurs over water, along waterways, forest edges, and in gaps in the forest (COSEWIC 2013). It is unlikely that the LAA supports any bat hibernacula, but foraging habitat is abundant and roosting habitat may exist within the PDA where there are large-diameter trees or suitable anthropogenic structures. No bats have been incidentally detected during field studies for other species undertaken in support of this Project and directed bat studies were not undertaken.

In 2018, a federal recovery strategy was developed that provides guidance aimed at halting and reversing population decline of these three bat species. Critical habitat for the species does not occur within the LAA (ECCC 2018a).

8.4 EFFECTS ASSESSMENT

8.4.1 Assessment Criteria

8.4.1.1 Residual Effects Characterization

Table 8.2 presents definitions for the characterization of residual environmental effects on wildlife and wildlife habitat. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not possible.

Table 8.2 Characterization of Residual Effects on Wildlife and Wildlife Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to wildlife and wildlife habitat relative to baseline **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to wildlife and wildlife habitat relative to baseline
Magnitude	The change in wildlife abundance and/or distribution	**Negligible –** a measurable change in the abundance of wildlife in the LAA is not anticipated **Low –** a measurable change in the abundance of wildlife in the LAA is not anticipated, although temporary local shifts in distributions in the LAA might occur **Moderate –** a measurable change in the abundance and/or distribution of wildlife in the LAA might occur **High –** a measurable change in the abundance and/or distribution of wildlife may exceed the LAA
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the PDA **LAA –** residual effects extend into the LAA
Duration	The time required until the measurable parameter or the VC returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived ,	**Short term** – residual effect extends for less than 1 year **Medium term** – residual effect extends through the construction phase **Long term** – residual effect extends through the operation phase **Permanent** – recovery to baseline conditions unlikely
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not applicable –** effect does not occur during critical life stage or timing does not affect the VC **Applicable – e**ffect occurs during a critical life stage
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event –** the residual effect occurs once **Multiple irregular event –** the residual effect occurs at no set schedule **Multiple regular event –** the residual effect occurs at regular intervals **Continuous –** the residual effect occurs continuously
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and reclamation **Irreversible –** the residual effect is unlikely to be reversed

Table 8.2 Characterization of Residual Effects on Wildlife and Wildlife Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

8.4.1.2 Significance Definition

A significant adverse residual effect on wildlife and wildlife habitat is one that, following the application of avoidance and mitigation measures, threatens the long-term persistence or viability of SAR/SOCC.

8.4.2 Potential Project Interactions with Wildlife and Wildlife Habitat

Table 8.3 summarizes the potential environmental effects of Project activities on wildlife and wildlife habitat, the pathways by which they may affect wildlife and wildlife habitat, and the measurable parameters used for evaluating effects. Potential environmental effects and measurable parameters were selected based on professional judgment, recent environmental assessments in New Brunswick, and regulatory concern for certain species.

Table 8.3 Potential Environmental Effects, Effect Pathways, and Measurable Parameters for Wildlife and Wildlife Habitat

Potential Environmental Effects	Effect Pathways	Measurable Parameter(s)
Change in Habitat	Construction and operation and maintenance of the Project could result in a: • Direct loss or alteration of wildlife habitat (*e.g.*, vegetation clearing) • Indirect loss or alteration of wildlife habitat (*e.g.*, sensory disturbance, edge effects)	Qualitative evaluation of the amount of direct and indirect habitat lost or altered for wildlife, including for SAR and SOCC.
Change in Mortality Risk	Construction and operation and maintenance of the proposed project could result in a direct increase in mortality risk or number of wildlife fatalities (*e.g.*, vegetation clearing activities, vehicular collisions, human-wildlife conflicts).	Qualitative evaluation of direct mortality risk due to: • Vegetation clearing, site preparation, and maintenance • Collisions with Project vehicles or infrastructure

Table 8.4 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 8.4 Potential Interactions Between Physical Activities and Wildlife and Wildlife Habitat

Physical Activities	Change in Habitat	Change in Mortality Risk
Construction		
Site preparation	✓	✓
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	✓	–
Isolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	✓	–
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	✓	–
Shut down of power units	–	–
Fish passage	–	–
Transportation	✓	✓
Employment and expenditure	–	–
Operation and Maintenance		
Operation of the Mactaquac Generating Station (MQGS)	✓	✓
Maintenance of the MQGS	✓	✓
Fish passage	–	–
Notes: ✓ = Potential interaction – = No interaction		

Several planned Project activities and physical works will be limited in their footprint to existing infrastructure and adjacent and other non-naturalized areas and are therefore not expected to interact with wildlife and wildlife habitat, including shut down of power units, and fish passage during construction and operation. Changes in employment and expenditure are aspatial and not expected to interact with wildlife and wildlife habitat.

8.4.2.1 Potential Effects on Wildlife and Wildlife Habitat During Construction

Construction of the Project has the potential to interact with wildlife and wildlife habitat in the following ways:

- A direct loss of wildlife habitat will occur within the PDA for construction activities (*i.e.,* site preparation) that result in vegetation clearing and ground disturbance that physically removes habitat.
- An indirect loss or alteration of habitat may occur within the PDA and LAA for construction activities (*i.e.*, site preparation, in-water work, isolated work in the dry, work above water line, and transportation) that result in sensory disturbance (*i.e.*, noise and light emissions) that can result in avoidance or reduce the ecological effectiveness of habitats within and adjacent to the PDA.

- A direct increase in mortality risk may occur through construction activities (*i.e.*, site preparation, transportation) that involve vegetation clearing and ground disturbance and/or the movement of machinery and traffic within the LAA as mobile equipment and construction traffic encounter wildlife.

8.4.2.2 Potential Effects on Wildlife and Wildlife Habitat During Operation and Maintenance

Operation and maintenance of the Project has the potential to interact with wildlife and wildlife habitat in the following ways:

- An indirect loss or alteration of habitat may occur within the PDA and LAA for operation and maintenance activities (*i.e.*, operation of MQGS, maintenance of MQGS) that result in sensory disturbance (*i.e.*, noise and light emissions) that can result in avoidance or reduce the ecological effectiveness of habitats within and adjacent to the PDA.
- A direct increase in mortality risk may occur through operation and maintenance activities (*i.e.*, operation of MQGS, maintenance of MQGS) that involve vegetation clearing and/or the movement of machinery and traffic within the LAA as mobile equipment and traffic encounter wildlife.

8.4.3 Mitigation for Wildlife and Wildlife Habitat

The following mitigation measures applicable to wildlife and wildlife habitat have been identified for this Project.

- The Project will use previously disturbed areas for Project infrastructure and workspaces to the extent practicable.
- Vegetation clearing will be limited to areas required for construction and safe operations.
- Travel of vehicles will be confined to existing roads and trails to avoid disturbing vegetated areas.
- Equipment will be cleaned prior to mobilization to avoid introduction of invasive species.
- Material stockpiles will be kept a minimum of 30 m from a watercourse or waterbody with the appropriate erosion control mitigation in place to prevent sediment from entering a watercourse or waterbody.
- Vegetation clearing will be completed outside the migratory bird nesting period of April 12 to August 27 (Zone C3; ECCC 2018b). Where activities may result in risk of harm to migratory bird nests during this period (*e.g.*, limited vegetation clearing, nesting on Project infrastructure) or during the nesting period for other species (*i.e.*, raptors), a qualified biologist will complete a pre-activity nest survey in accordance with federal guidelines (ECCC 2022).
- If an active bird nest is found, beneficial management practices will be followed, including applying an appropriate setback and timing restriction, and NB Fish & Wildlife and/or Canadian Wildlife Service (CWS) will be consulted, as appropriate.
- Vegetation clearing will be completed outside the core maternity roosting period for bats of May 1 to August 31. If habitat tree removal or general tree clearing is required during the maternity roosting period, a qualified biologist will review the trees to determine bat occupancy before removal.
- Vehicle and equipment emissions will be managed by conducting regular maintenance on all machinery and equipment.
- Idling of vehicle engines, equipment, and machinery will be avoided where possible.

- Haul routes will be managed to reduce engine idling and dust.
- Haul distances to disposal sites will be reduced where possible.
- Construction-related fugitive road dust will be controlled through measures such as speed limits on Project-controlled gravel roads and road watering on an as-needed basis.
- Disturbed areas will be revegetated as soon as possible to limit dust emissions.
- Construction activities that have the potential to generate noise disturbance will be limited to daytime hours as feasible to limit nuisance noise to off-site receptors at night.
- All staff will report wildlife incidents to their supervisor which will be reported to NB Fish & Wildlife and/or CWS, as appropriate.
- Personnel will not feed, harass, or hunt wildlife while working on the Project.
- Food and other wildlife attractants will be stored in odour-proof containers.
- Crews will be trained on wildlife awareness.
- Food waste will be stored and disposed of in a manner to avoid attracting wildlife.

8.4.4 Characterization for Residual Project Environmental Interactions for Wildlife and Wildlife Habitat

8.4.4.1 Residual Effects on Wildlife and Wildlife Habitat During Construction

Change in Wildlife Habitat

The PDA provides limited habitat opportunities for most wildlife species as it has been subject to anthropogenic disturbance via the initial construction and operation and maintenance of the MQGS. The PDA consists primarily of altered habitats (*e.g.*, mowed lawn) interspersed with small patches of mixed wood trees, deciduous shrubs, and planted coniferous tress that provide limited habitat opportunities, except for species tolerant of anthropogenic disturbance (*e.g.*, American Robin). Species that nest on anthropogenic structures (*e.g.*, Barn Swallow) may be adversely affected if construction activities are required where suitable nesting sites exist on existing infrastructure. However, although Barn Swallows were detected during breeding bird surveys conducted for the Project, no Barn Swallows have been detected nesting on Project infrastructure to date. Direct habitat loss and alteration is anticipated to be temporary as the habitats will be returned to a similar condition post-construction, except for where tree removal is required.

The PDA and LAA are currently subject to chronic anthropogenic noise (*e.g.*, traffic, water falling over the spillway, the powerhouse) and light emissions, and construction of the Project is anticipated to result in a minor incremental increase in existing emissions levels (Section 6.2.5). Construction noise is typically intermittent, fluctuates during active construction, will occur during daytime only, and is generally confined to the LAA where wildlife are subject to existing anthropogenic sources of sensory disturbance. Indirect habitat loss and alteration is anticipated to be temporary as the habitats will be returned to a similar condition as currently following construction. Most wildlife species expected to occur within the PDA and LAA, including SAR and SOCC, are currently exposed to a high degree of anthropogenic disturbance and are anticipated to be unaffected by the incremental increase in sensory disturbance resulting from the Project, but portions of the LAA may temporarily be avoided by some species.

Following the implementation of mitigation measures described above, residual effects relating to change in habitat during the construction phase are summarized in Table 8.5 and characterized by the following:

- Direction is adverse: there will be a direct and indirect loss or alteration of wildlife habitat, but the habitats have been previously altered and/or are subject to a high degree of anthropogenic disturbance.
- Magnitude is low: a measurable change in the abundance of wildlife in the LAA is not anticipated, although temporary local shifts in distributions in the LAA might occur.
- Geographic extent is the LAA: direct and indirect loss or alteration of habitat associated with sensory disturbance is unlikely to exceed the LAA.
- Duration is medium term: sensory disturbance will cease following the construction phase.
- Timing is applicable as construction will occur throughout the year, including during sensitive periods for wildlife (*e.g.*, nesting).
- Frequency is continuous: effects will occur throughout the construction phase.
- Change is reversible: sensory disturbance will cease following the construction phase.
- Ecological and socioeconomic context: the Project is situated in a highly altered landscape subject to existing anthropogenic disturbances.

Change in Wildlife Mortality Risk

As described above, the PDA provides limited habitat value for wildlife due to existing levels of anthropogenic disturbance and the potential for wildlife to interact with mobile equipment and traffic resulting in injury or mortality is anticipated to be low. Despite increased mobile equipment use and traffic, the proposed mitigation measures will further reduce the potential for the Project to interact with wildlife and the risk to wildlife will cease following construction.

Following the implementation of mitigation measures described above, residual effects relating to change in mortality risk during the construction phase are summarized in Table 8.5 and characterized by the following:

- Direction is adverse: construction activities will increase wildlife mortality risk.
- Magnitude is negligible: a measurable change in the abundance of wildlife in the LAA is not anticipated.
- Geographic extent is the LAA: mortality risk will be localized and not exceed the LAA.
- Duration is medium term: mortality risk will cease following the construction phase.
- Timing is applicable as construction will occur through the year, including during sensitive periods for wildlife (*e.g.*, nesting).
- Frequency is continuous: effects will occur throughout the construction phase.
- Change is reversible: mortality risk will cease following the construction phase
- Ecological and socioeconomic context: the Project is situated in a highly altered landscape subject to existing anthropogenic disturbances.

8.4.4.2 Residual Effects on Wildlife and Wildlife Habitat During Operation and Maintenance

Change in Wildlife Habitat

Project activities that may result in indirect habitat loss or alteration (*i.e.*, sensory disturbance) during the operation and maintenance phase are not expected to differ from activities undertaken during baseline conditions. Except for wildlife avoidance due to sensory disturbance, no additional change in wildlife habitat is anticipated to occur during the operation and maintenance phase that was not already lost or altered during the construction phase. As a result, residual effects on wildlife and wildlife habitat during operation and maintenance of the Project are anticipated to be negligible.

Following the implementation of mitigation measures described above, residual effects relating to change in habitat during the operation and maintenance phase are summarized in Table 8.5 and characterized by the following:

- Direction is adverse: there will be an indirect loss or alteration of wildlife habitat, but the LAA is subject to a high degree of anthropogenic disturbance.
- Magnitude is negligible: a measurable change in the abundance of wildlife in the LAA is not anticipated.
- Geographic extent is the LAA: indirect loss or alteration of habitat associated with sensory disturbance is unlikely to exceed the LAA.
- Duration is long term: sensory disturbance will extend through the operation and maintenance phase.
- Timing is applicable as construction will occur throughout the year, including during sensitive periods for wildlife (*e.g*., nesting).
- Frequency is continuous: effects will occur throughout the operation and maintenance phase.
- Change is reversible: indirect habitat loss or alteration will persist throughout the life of the Project.
- Ecological and socioeconomic context: the Project is situated in a highly altered landscape subject to existing anthropogenic disturbances.

Change in Wildlife Mortality Risk

Project activities that may result in increased mortality risk (*i.e.*, vegetation maintenance, movement of machinery or traffic) during the operation and maintenance phase are not expected to differ from activities undertaken during baseline conditions. As a result, residual effects on wildlife and wildlife habitat during operation and maintenance of the Project are anticipated to be negligible.

Following the implementation of mitigation measures described above, residual effects relating to change in mortality risk during the operation and maintenance phase are summarized in Table 8.5 and characterized by the following:

- Direction is adverse: operation and maintenance activities will increase wildlife mortality risk but are not anticipated to differ from activities undertake during baseline conditions.
- Magnitude is negligible: a measurable change in the abundance of wildlife in the LAA is not anticipated.

- Geographic extent is the LAA: mortality risk will be localized and not exceed the LAA.
- Duration is long term: mortality risks will extend through the operation and maintenance phase.
- Timing is applicable as operation and maintenance will occur throughout the year, including during sensitive periods for wildlife (*e.g*., nesting).
- Frequency is continuous: effects will occur throughout the operation and maintenance phase.
- Change is reversible: mortality risk will cease following the operation and maintenance phase
- Ecological and socioeconomic context: the Project is situated in a highly altered landscape subject to existing anthropogenic disturbances.

8.4.4.3 Summary of Project Residual Effects

A summary of the residual environmental effects characterization (Table 8.2), following the application of mitigation measures described in Section 8.4.3, on wildlife and wildlife habitat during the construction and operation and maintenance phases of the Project is provided in Table 8.5.

Table 8.5 Project Residual Effects on Wildlife and Wildlife Habitat

Residual Effect	Residual Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Habitat	C	A	L	LAA	MT	A	C	R	D
	O	A	N	LAA	MT	A	C	I	D
Change in Mortality Risk	C	A	N	LAA	LT	A	C	R	D
	O	A	N	LAA	LT	A	C	I	D

KEY
See Table 8.2 for detailed definitions

Project Phase
C: Construction
O: Operation and Maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not Applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

8.5 DETERMINATION OF SIGNIFICANCE

The Project involves construction and operation and maintenance activities at the existing MQGS where there is currently a high degree of landscape alteration and anthropogenic disturbance. Overall, the PDA provides limited habitat opportunities for wildlife and there is an abundance of similar habitats in the LAA and beyond. The wildlife species that occur within the LAA are unlikely to be affected by the temporary incremental change in habitat and mortality risk resulting from the Project and conditions.

With the application of mitigation measures, residual effects on wildlife and habitat are not expected to threaten the long-term persistence or viability of SAR/SOCC. The residual environmental effects of the Project on wildlife and wildlife habitat during all phases of the Project are not significant, with a high level of confidence.

8.6 FOLLOW UP AND MONITORING

A dedicated follow-up and monitoring plan is not required for wildlife and wildlife habitat to verify the environmental effects predictions of the assessment or to verify the effectiveness of mitigation.

8.7 REFERENCES

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9.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WATER RESOURCES

9.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

Water resources, as it pertains to the quality and quantity of both surface water and groundwater, is an important component of an ecosystem and is integrally linked to several other valued components (VCs). River flow affects the velocity, depth, sediment transport, ice flow regime (and associated potential for flooding), water quality, temperature, and oxygen levels within a surface water system.

Groundwater is an important water resource, supplying domestic and municipal drinking water, as well as agricultural, commercial, and industrial uses. Ecologically, groundwater can supply flows to surface waters during dry periods, regulates surface water temperatures, and is an important component of spawning habitat for fish species that spawn on the river bottom.

Water resources was selected as a VC because of its importance to natural and human environments, particularly with respect to the aquatic nature of the Project with work anticipated to occur in or near water (*i.e.*, repair to the dam infrastructure).

9.2 SCOPE OF ASSESSMENT FOR WATER RESOURCES

9.2.1 Regulatory Context

Provincially, the New Brunswick *Clean Water Act*, administered by New Brunswick Department of Environment and Local Government (NBDELG), is in place to protect water, including surface waters, recreational waters, and existing and future sources of drinking water. Under this Act, potable water is regulated under the *Potable Water Regulation*. The *Watercourse and Wetland Alteration Regulation* (WAWA regulation) provides protection for wetland and surface water sources. The WAWA regulation requires a permit for any activity that will result in a temporary or permanent change to a watercourse or wetland or changes within 30 m of a watercourse or wetland. The *Water Classification Regulation* under the *Clean Water Act* is intended to provide a classification scheme for lakes and rivers of the province to achieve defined water quality goals; to date, only lakes have been classified and the program is currently being reviewed under a broader land and water management framework.

The *Clean Water Act* also protects groundwater and associated wells for personal or municipal water supply. Water wells are regulated under the *Potable Water Regulation* and *Water Well Regulation* which set standards for groundwater well setbacks, groundwater well construction, testing and decommissioning, and water quality sampling. Under the *Potable Water Regulation*, the Province of New Brunswick maintains a database of groundwater quality data collected from domestic water wells drilled since 1994.

Surface water quality in New Brunswick is regulated under the *Water Quality Regulation* under the New Brunswick *Clean Environment Act*. The Minister of the Environment and Climate Change (the Minister) may grant approvals under the *Water Quality Regulation* for sources or activities that will result in releases of contaminants to the waters of the province. Where any changes to water quality may occur, the Minister may also set water quality limits of a facility's discharge, as part of an Approval to Operate.

Federally, Health Canada's Guidelines for Canadian Drinking Water Quality (GCDWQ) pertain to potable water and have been adopted by the Canadian Council of Ministers of the Environment (CCME), though the guidelines have no force of law unless formally adopted by provincial regulation. The federal *Fisheries Act* regulates maintenance flow and fish passage and restricts the release of deleterious substances to waterbodies. Water withdrawal from the St. John River through the MQGS hydroelectric intakes must satisfy site maintenance flow requirements downstream of the MQGS for the protection of aquatic life. Establishment of maintenance flow requirements should consider the average annual flow in the channel, fish or other aquatic organisms, aquatic habitat, and fish passage.

9.2.2 Spatial Boundaries

The assessment of potential environmental interactions between the Project and water resources is focused on a Project development area (PDA) and local assessment area (LAA) (Figure 9.1).

The PDA for the Project is defined as the area of physical disturbance associated with the construction and operation and maintenance of the Project as described in Section 2. For the purposes of this assessment, the PDA includes the upstream extents of the dam infrastructure, and downstream extents of the cofferdams installed during the construction phase.

The LAA for water resources is defined as the area within which the environmental effects of the Project can reliably be measured or predicted. For considering a potential change in the water resources, the LAA for water resources follows the domain chosen for water quality, which focuses on the activities occurring within the PDA plus approximately 10 km upstream and 1 km downstream of the MQGS. The LAA can be thought of as the theoretical "zone of influence" of the Project on water resources.

Figure No.
9.1
Title
Spatial Boundaries for Water Resources

Client/Project 121415886_019

NB Power
Mactaquac Life Achievement Plan

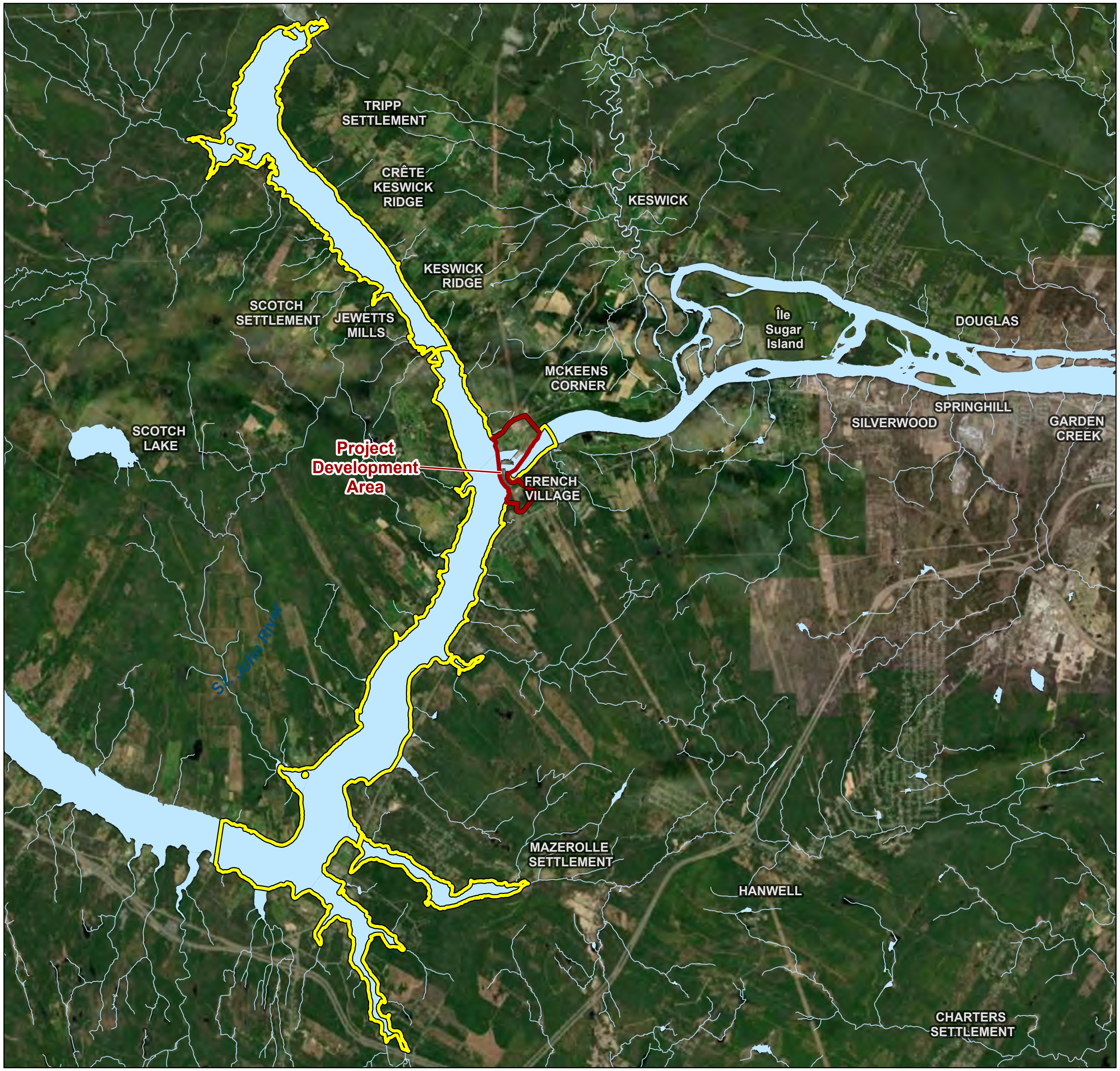
Project Location Prepared by MB on 2023-01-18
Mactaquac Generating Station
York County, NB

N

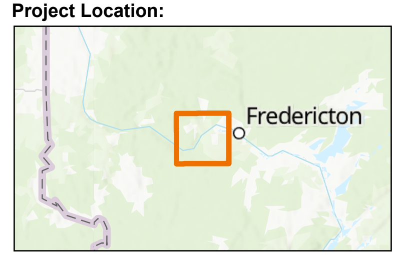
0 1 2 Kilometres
(At original document size of 8.5x11)
1:130,000

Legend

Project Devleopment Area
Local Assessment Area
Roads
Watercourse
Waterbody



Project Location:



Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB, Service NB, NB DNR
3. Background: GeoNB, Service NB

Stantec

\\Ca0181-ppfss01\workgroup\1214\active\121415886\gis\6_mapping\ArcGIS Pro\121415886 Mactaquac\121415886 MLAP.aprx Revised: 2023-01-18 By: mblackwood

9.2.3 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects on water resources include:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and Maintenance – scheduled to begin following construction and last until approximately 2068

Decommissioning will occur following the useful service life of the facilities and will be carried out in accordance with regulations in place at that time.

9.3 EXISTING CONDITIONS FOR WATER RESOURCES

9.3.1 Approach and Methods

The existing surface water conditions were characterized based on a review of the following sources of information:

- Published databases and digital maps, including:
  - the Water Survey of Canada HYDAT database (ECCC 2022a)
  - the New Brunswick Waters database (NB Waters 2022)
  - the Fresh Water Quality Monitoring and Surveillance mapping application (ECCC 2022b)
  - the New Brunswick Digital Topographic Database (SNB 1998)
  - the “Before the Mactaquac Headpond” story map (Holman 2014)
  - navigational charts of the St. John River (CHS 1969)
  - the New Brunswick Hydrographic Network geographic dataset (NBDNRED 2022)
- Service New Brunswick property information (SNB 2022)
- Interviews with relevant government departments
- Results of field programs and analyses conducted for the Mactaquac Aquatic Ecosystem Study (MAES) being conducted by the Canadian Rivers Institute (CRI), including a bathymetric survey, LiDAR survey (Leading Edge Geomatics 2014), and water and sediment sampling (Kidd *et al*. 2015)
- Past research, studies, or assessments conducted in the region

Existing groundwater characteristics were determined using desktop research of sources such as the NBDELG’s Online Well Log System (OWLs), GeoNB, and past research, studies, or assessments conducted in the region.

9.3.2 Description of Existing Conditions

9.3.2.1 Surface Water

Watershed Characteristics

The St. John River (Wolastoq) is the largest river in Atlantic Canada (Figure 9.2). Located principally in New Brunswick but extending into Maine and Québec, it flows approximately 700 kilometres (km) from its origin at Little Saint John Lake in Maine to the Bay of Fundy at Saint John. The tides in the Bay of Fundy cause the river level to fluctuate as far upstream as Fredericton (MacLaren 1979).

The St. John River watershed basin, as shown in Figure 9.2, occupies an area of 55,100 square kilometres (km^2). The watershed receives an average of 1,077 millimetres (mm) of precipitation per year, based on the Canadian Climate Normals (1981 to 2010) for the Fredericton Airport weather station, located approximately 30 km east of MQGS (ECCC 2022a). The Fredericton Airport weather data are generally representative of average weather conditions in central New Brunswick. Most of the precipitation occurs as rainfall, with snowfall accounting for an average of 219 mm of water column equivalent precipitation per year (ECCC 2022a). These precipitation rates result in flowrates in the St. John River at Mactaquac ranging from approximately 280 cubic metres per second (m^3/s) in summer, to more than 10,000 m^3/s during the spring freshet (Newton 2011).

According to MacLaren (1979), the St. John River drops a total of 480 m in elevation along its length. MQGS is situated at a location of natural change in slope along the river. Portions of the river upstream of MQGS have slopes that are steeper than those downstream. The steeper upstream slopes provide suitable conditions for the generation of hydroelectric power. In total, 10 major dams (for either water storage or hydroelectric generation) are located on the St. John River and its major tributaries, some of which are operated as an integrated power system by NB Power (*i.e.*, Grand Falls, Sisson, Tobique, Beechwood, and Mactaquac stations).

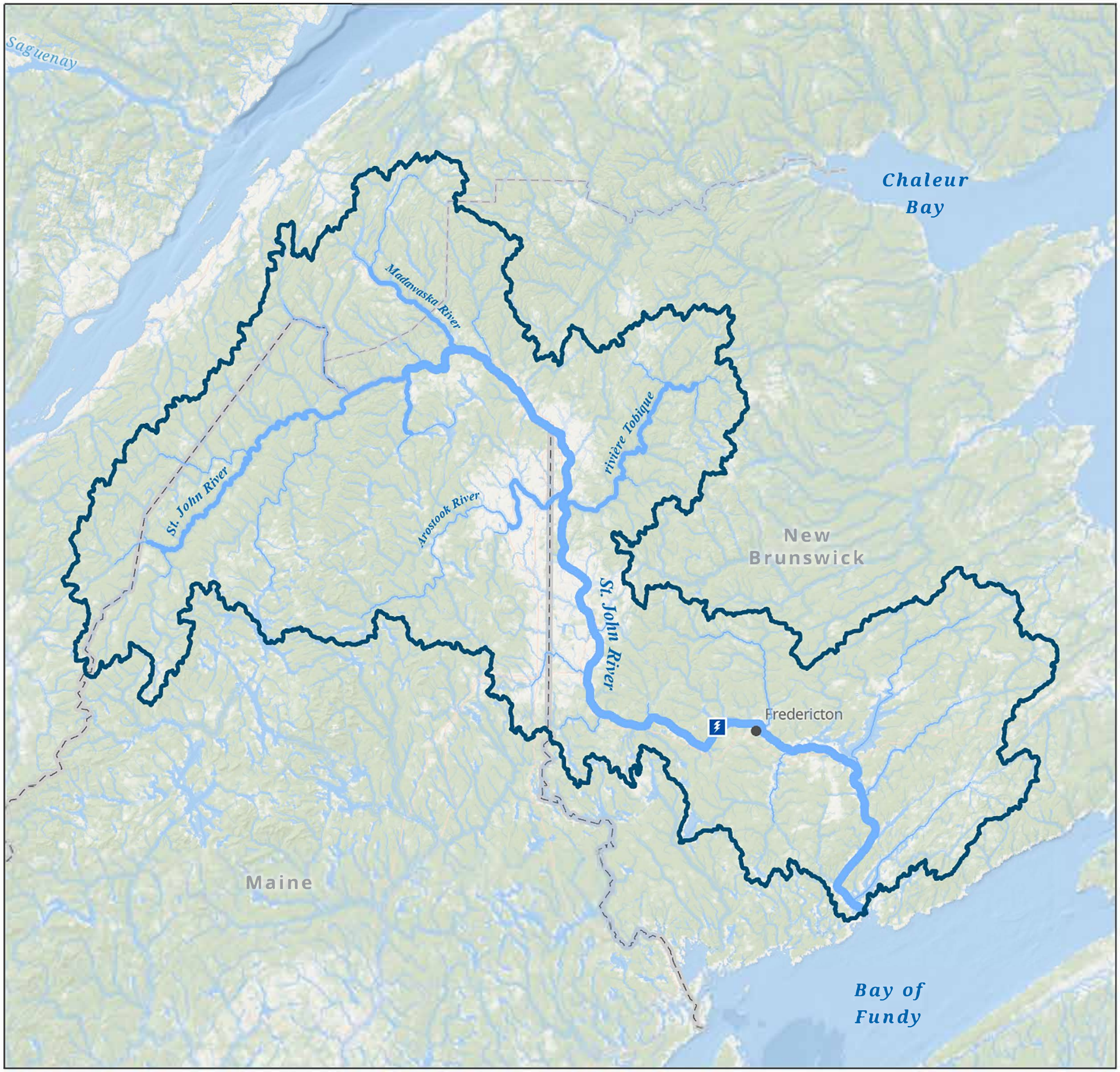


Figure No.
9.2

Title

Mactaquac MLAP
St. John River Basin

Client/Project 121415886_017

NB Power
Mactaquac Life Achievement Project

Project Location Prepared by NW on 2022-09-01
Mactaquac Generating Station
York County, NB

N

0 25 50 Kilometres
(At original document size of 8.5x11)
1:2,500,000

Legend

- Mactaquac Hydroelectric Generating Station
- St. John River Basin
- Watercourse
- Waterbody

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: HydroSHEDS, HydroRIVERS, New Brunswick Hydrographic Network, Service NB
3. Background: Province of New Brunswick, Esri Canada, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS, NRCan, Parks Canada, CHS, Esri, GEBCO, DeLorme, NaturalVue

Stantec

Drainage areas of the St. John River (and its tributaries) were calculated using a digital elevation model (DEM) of the ground surface collected as part of the Mactaquac Aquatic Ecosystem Study (MAES) being carried out by the Canadian Rivers Institute (CRI) on behalf of NB Power. As shown in Table 9.1, the drainage area was calculated at the upstream boundary of the headpond (Hartland, NB), the downstream boundary of the LAA (Fredericton, NB), and at MQGS.

Table 9.1 Drainage Area of the St. John River at Key Locations

Location	Distance from Station (km)	Drainage Area (km²)
Downstream of Hartland, NB	97 (upstream)	35,730
MQGS	0	39,898
Fredericton, NB	20 (downstream)	44,934

A review of the New Brunswick Hydrographic Network (NBHN) database (NBDNRED 2022) identified more than 200 tributaries that flow into to the MQGS headpond which extends approximately 97 km upstream from the MQGS. These tributaries transport collected runoff from the drainage area to the St. John River. As a result, the flow rate of the river increases downstream as more tributaries join the river. Apart from the St. John River itself, major upstream tributaries that flow into the headpond include the Meduxnekeag River, Eel River, Shogomoc Stream, Longs Creek, Kellys Creek, Nackawic Stream, Pokiok Stream, and Mactaquac Arm (formerly the Mactaquac Stream). Major downstream tributaries include the Keswick River, Nashwaak River, Oromocto River, and Kennebecasis River.

The characteristics of key features of the St. John River within the LAA are listed in Table 9.2. The calculations are based on a geographic information systems (GIS) analysis of the 2014 aerial imagery combined with the calculated NBDNRED (2022) data river features in the headpond.

Table 9.2 Key Features of the St. John River within the LAA

River Features	40 km Upstream of MQGS	20 km Downstream of MQGS to Fredericton
Wetted channel area (km²)	83.2	42.3
Average channel width / depth (m) [b]	740/26 [a]	600/6.6
Area of islands (km²)	0.43 [a]	18.0
Shoreline perimeter of islands (km)	18.4 [a]	125.4
Total shoreline perimeter (km)	354.6	236.7

Source:

[a] Measured by Stantec (2016).

[b] Based on average depth and width measured every 10 km (CRI 2014).

Flow Regime

Routine monitoring of watercourses in New Brunswick conducted by the Water Survey of Canada (WSC) has established long-term records of flow regimes throughout the province. Several WSC stations exist along the St. John River. Two of the WSC stations were used to characterize the upstream and downstream flow regime of the river, including:

- The St. John River downstream of Mactaquac Station (WSC ID 01AK004), located 3.5 km downstream of MQGS
- The St. John River near East Florenceville station (WSC ID 01AJ001), located 118 km upstream of MQGS

Table 9.3 summarizes the minimum, mean, and maximum daily flow records for each WSC station. NB Power provided the mean annual river flow downstream of MQGS as 813 m^3/s.

Table 9.3 Flow Regime Characteristics of the St. John River near the MQGS

Water Survey of Canada (WSC) Hydrometric Station	Period of Record	River Flow (m^3/s)			Drainage Area (km^2)
		Minimum	Mean	Maximum	
St. John River near East Florenceville (01AJ001)	1951–1991	13	663	9,170	34,200
St. John River downstream of Mactaquac Station (01AK004)	1961–1995	21	813	11,100	39,000

Average daily flow records from these WSC stations were used to generate the unit flow, as shown in Figure 9.3. The unit flow represents the average daily flow divided by the drainage area upstream of the WSC hydrometric stations. It is useful to show that, when drainage areas of the same size are compared, the WSC stations show essentially the same river flow response. As shown in the figure, the highest flows in the St. John River occur in April and May, corresponding to the spring freshet. Flow is slightly higher in the fall (October to December) compared with drier months of January, February, July, and August.

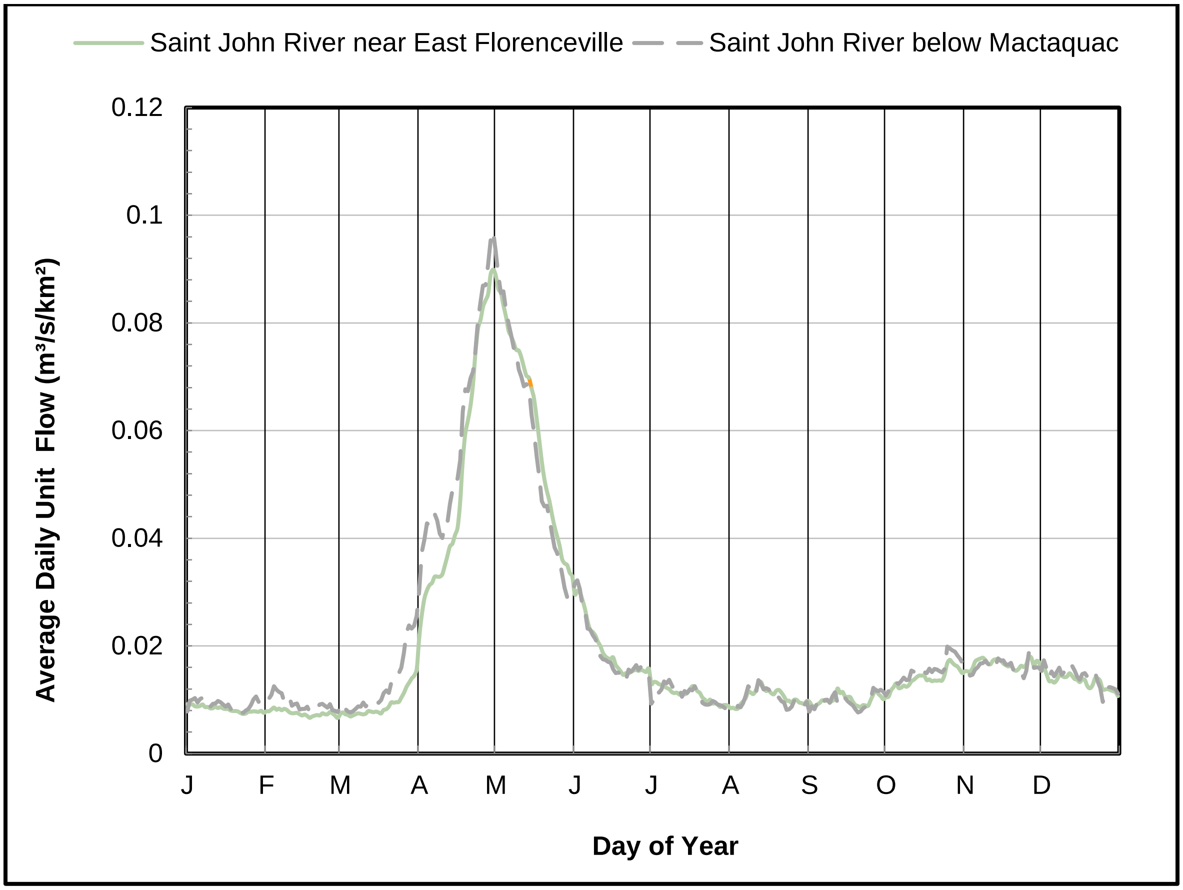


Figure 9.3 WSC Mean Monthly Unit Flow Hydrographs (ECCC 2022a)

Power generation at Mactaquac is largely controlled by the natural flow of the river (known as "run-of-river"). MQGS is operated as a peak-load plant during periods of low flow, and as a base-load plant during periods of high flow (Jessop and Harvie 2003). During the peak-load cycle, which typically occurs in summer, the natural river flow is controlled to meet daily energy demands (Jessop and Harvie 2003). Sudden changes in water level occur during peak periods of power demand (*e.g.*, 07:00 hours (h), 12:00 h, and 17:00 h), although these fluctuations are not observable when reviewing the WSC average daily unit flow records downstream. As the MQGS is operated run-of-river, in which flows generate hydroelectricity as they enter the dam, the MQGS does not maintain significant seasonal storage in the headpond. The water elevation in the headpond is normally maintained between 39 and 40.5 m (128 and 133 ft) above mean sea level (amsl) during normal operating conditions and based on these water levels, inflows to the MQGS range between 2,265 to 5,663 m^3/s.

The MQGS is required to maintain a minimum flow during summer months, referred to as the ecological maintenance flow (EMF) and established by Fisheries and Oceans Canada (DFO). The EMF for the MQGS is 2,400 cubic feet per second (cfs) or 68 m^3/s (NB Power n.d.).

An analysis of the one-day minimum flows (m^3/s) for the St. John River from 1967 to 2012 was provided by NB Power. The analysis presents the river flows in terms of the return period, or the interval that the minimum river flow is likely to recur. Low flow events at MQGS for return periods of 1 in 10, 20, 50, and 100 years are presented in Table 9.5. For example, a 1Q10-year low flow event represents a 10% probability of a lower flow occurring in any one year and is more likely to recur than a 1Q100-year low flow event (*i.e.,* 1% probability of a lower flow occurring in any one year).

Table 9.4 Frequency of Low Flow Events at MQGS

Return Period (years)	Minimum River Flow (m^3/s)
1Q10	59
1Q20	49
1Q50	38
1Q100	31
Source: NB Power n.d.	

NB Power provided an estimate of potential flood flow in the LAA that may be caused by precipitation and/or melt events of varying magnitudes. Table 9.6 shows the frequency of flood flow events at MQGS for return periods of 1 in 2, 5, 10, 20, 50, 100, 1,000, and 10,000 years. The 1 in 1,000-year and 1 in 10,000-year return periods were included in the analysis of high river flow to capture a lower acceptable risk from flooding (*i.e.*, 0.1 and 0.01% probability of a flood event occurring any one year, respectively).

Table 9.5 Frequency of Flood Events at MQGS

Return Period (years)	Maximum River Flow (m^3/s)
1:2	5,497
1:10	8,030
1:20	8,998
1:50	10,251
1:100	11,190
1:1,000	14,292
1:10,000	17,388
Source: NB Power n.d.	

The CRI (2011) reports that the frequency and magnitude of large floods in the St. John River has increased since 1968 due to changes in climate in the St. John River watershed. This is not attributed to the construction of MQGS (CRI 2011).

Ice Jams and Related Flooding

The St. John River has solid ice cover in winter except for downstream of Edmundston, where the water is warmed by paper mill effluents, and immediately below MQGS due to higher turbulence in the river flow. The average ice thickness in the MQGS headpond between 1976 and 2004 was approximately 50 cm (NBDTI 2015). This thickness is consistent with the New Brunswick average ice thickness (50 cm) reported by LeBrun-Salonen (1983). On the St. John River, spring breakup usually occurs during the second or third week of April (LeBrun-Salonen 1983).

Ice jams are caused by the breakup and rapid accumulation of fragmented river ice and can cause dramatic river flooding events (Environment Canada 2011). The major factors affecting ice breakup include the rate of snowmelt and rainfall and the subsequent runoff. The water level rises from the added input to the river system exerting pressure on the ice cover and forcing the ice to break up. As the ice moves downstream, it lodges on bars, islands, and at bridge piers (Environment Canada 2013).

In New Brunswick, approximately 70% of recorded flood damages have been caused by ice-related floods (Environment Canada 2011). Historic flood events caused by ice jams have been recorded at multiple locations on the St. John River, including but not limited to the spring floods of 1887, 1936, 1976, 1987, 1991, 1993, and 2012 (NBDELG 2013). These events resulted in extensive damage, including washouts of bridges and roads. For example, the former Jewett's Mills bridge at Mactaquac was carried away in 1887, the Canadian Pacific Railway bridge in Woodstock was washed out in 1976, and the Sharps Island Railway bridge was washed out in 1987. Reports on floods on the St. John River date to the late 1780s, although this earlier information is limited.

Data on the occurrence of ice jam events upstream and downstream of MQGS were compiled based on the published ice jam location data as well as the ice jam database maintained by NBDELG (2013). The results are shown in Figure 9.4 for three reaches, or segments, of the river:

- Downstream: One reach downstream of MQGS with a reach length based on half the length of the headpond (48.5 km downstream of MQGS) (labelled "Downstream")
- Upstream: Two upstream reaches of MQGS generally correlated to lengths also based on half the length of the headpond; these are the upper and lower portions of the headpond reaches (labeled as "Upper Headpond" [97 to 48.5 km upstream of MQGS] and "Lower Headpond" [48.5 to 0 km upstream of MQGS])

Historical locations of ice jam events are shown in Figure 9.4 (NBDELG 2013).

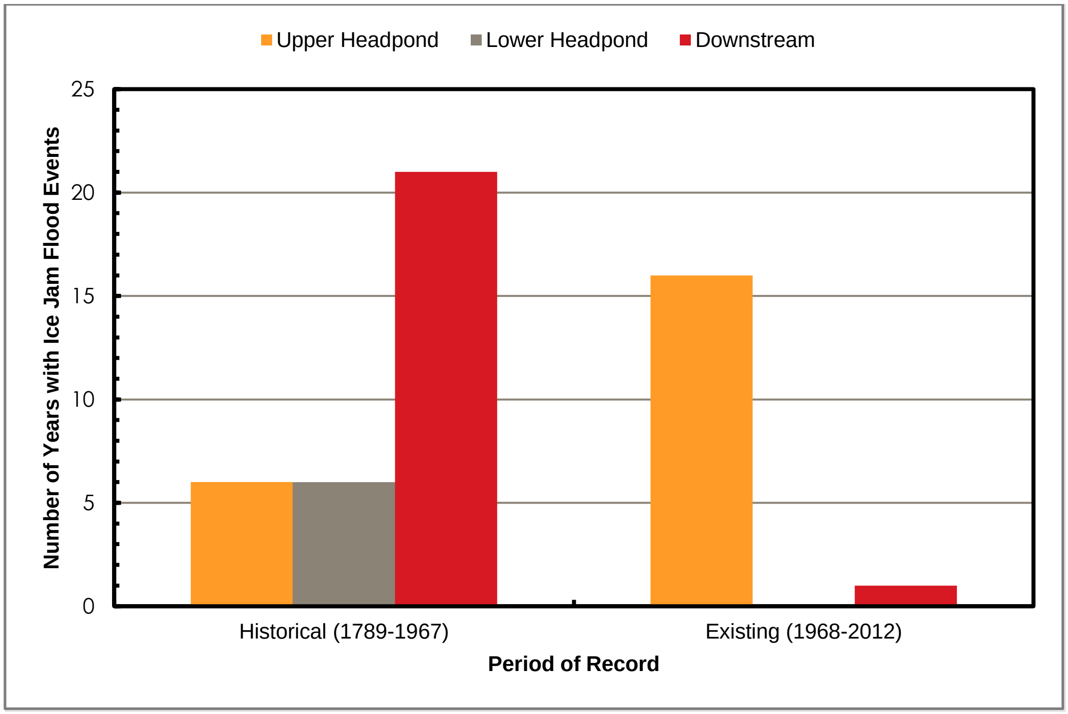


Figure 9.4 Occurrence of Ice Jams Upstream and Downstream of MQGS

As shown in Figure 9.4, from 1968 to 2012, 16 ice jams occurred in the upper headpond, none in the lower headpond, and 1 downstream of MQGS. Before construction of MQGS (*i.e.,*1967 and earlier), there were approximately six ice jams in the upper headpond, six in the lower headpond, and just over 20 downstream of MQGS. While the historical length of record is much longer than the existing record, many historic ice jam flood events may not have been reported. Since the construction of MQGS, routine flood monitoring and event reporting has occurred because of higher potential damages due to more extensive development within the watershed.

The headpond allows for the formation of a thick and extensive ice sheet. This ice sheet is held in the lower headpond, and melts in place prior to spilling over the dam. MQGS prevents the migration of large amounts of ice downstream, thus preventing ice jams from occurring both in the lower headpond and downstream. The upper headpond generally has ice break-up in the spring, which encounters a barrier in the more intact ice sheet in the lower headpond, thus making the upper headpond more prone to ice jams.

Since construction of the MQGS, ice jam flooding downstream of MQGS as far as Coytown (67 km downstream of MQGS) has occurred only once,in 1970and was likely caused by the release of ice from the Nashwaak River. This suggests that ice jam flooding could occur again downstream; however, the frequency of downstream flooding is greatly reduced as a result of MQGS.

Sediment Characteristics

The St. John River transports sediment suspended in its flow (known as suspended load) and redispersed sediment at or near the bottom of the river (known as bed load). The quantity of sediment that is transported by a river depends on the instantaneous flow in the river, bed and water column characteristics, as well as features of the watershed, including its size, geological and physical characteristics, and the land use within the watershed.

Higher flows can transport larger quantities of sediment because of higher velocities, which in turn can apply higher shear forces to sediment. Once sediments enter the stream, the river system strives to reach equilibrium between the force that moves the sediment downstream (*i.e.*, the flow in the river) and the force that holds the sediment in place (*i.e.*, gravitational drag).

When river flow is altered, sediment movement patterns can also be affected. For example, sediment movement in the St. John River has changed because of changes in flow characteristics (*i.e.*, increased water elevations and reduced water velocities) since construction of MQGS. The reduction in water velocities caused by raising the headpond has created higher sediment deposition rates (meaning larger sediment particles are found at the upstream sections of the headpond), while smaller sediment particles travel farther or even pass the dam structure. This change in sediment movement will continue for the life of the MQGS.

Particle Size Distribution

Sediment samples from the headpond were collected and analyzed by CRI in 2014 to better understand sediment characteristics. Figure 9.5 shows the variable particle size distributions along the headpond (Chateauvert *et al*. 2015) using the “Wentworth” size class for particle diameters in micrometres (µm). The particle size distribution is defined using D10, D50, and D90, which refer to percentile below the diameter of each respective particle.

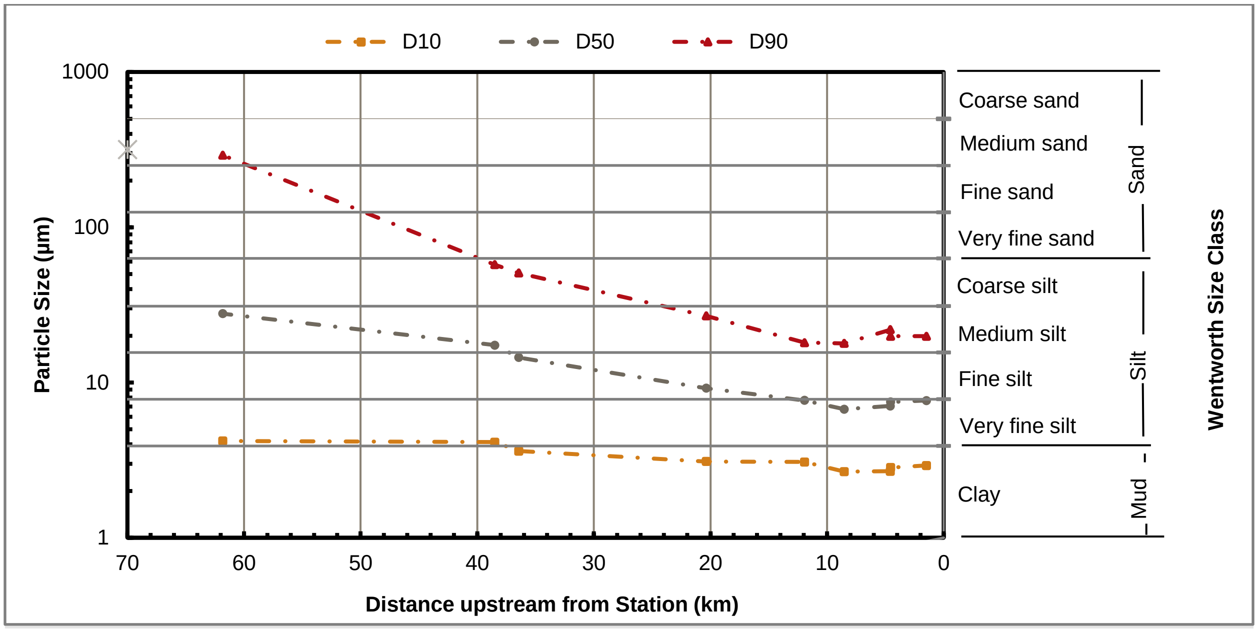


Figure 9.5 Particle Size Distribution in the Headpond

As expected, larger particles (very fine silt to medium sand) were found in the upper reaches of the headpond, while particle size was smaller towards the middle areas of the headpond (very fine silt to very fine sand) and near MQGS (very fine silt to coarse silt). This is because only smaller particles are able to reach the lower reaches of the headpond (Chateauvert *et al*. 2015) due to the reduction in transport velocity. This is consistent for most dams, although the quantity of sediment that is trapped in the headpond is unique to each dam.

Sediment samples were taken at Fredericton, 20 km downstream of MQGS. The average D10, D50, and D90 were found to be 35, 413, and 666 µm respectively. These values indicate the sediment downstream of MQGS is classified as coarse silt to coarse sand.

Suspended Load and Flow Rates

Limited measurements of suspended load were taken by Environment Canada at monitoring station 01AK004, downstream of MQGS, though data exist only for November 1966 to November 1967. Since MQGS was not operational until 1968, these sediment measurements reflect conditions before flows were fully altered by the dam. Sediment loads and flow rates for 1967 are shown in Figure 9.6.

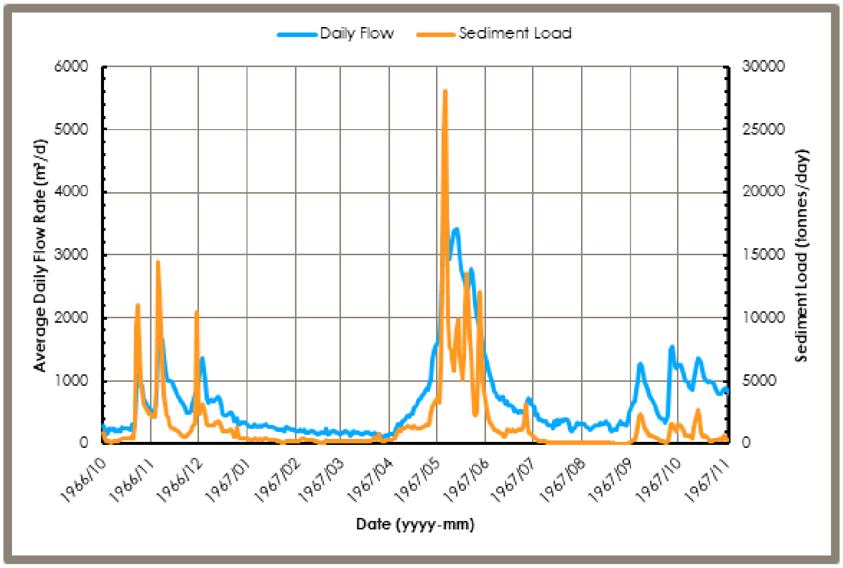


Figure 9.6 Sediment Loads and Flow Rates downstream of MQGS – 1966-1967 (Environment Canada 2015)

Figure 9.6 shows a correlation between suspended load and river flow rates. The largest suspended load amounts occurred during the spring freshet in May, when river flows were highest and had more capacity to carry sediments; the lowest sediment loads occurred during low river flow conditions in August. The data also show a quick response between the occurrence of peak times between flows and sediment amounts. The total suspended load estimate between November 1, 1966 and October 31, 1967 was 559,332 tonnes (t). The average suspended sediment concentration for the same period was 18.2 mg/L, with maximum and minimum concentrations ranging from 140.2 mg/L to 0.9 mg/L, respectively.

The average sediment input measured just downstream of the future location of the MQGS for one year of WSC record (1966–1967) was 14 t/km^2. This is comparable to the sediment input in the Kennebecasis River at the Apohaqui Station (19.1 t/km^2) and falls within the range of 6.4 to 29.4 t/km^2 observed in three watersheds in New Brunswick (Bray and Xie 1993).

Sediment Deposition and Erosion

A total of eight cross sections were created within the headpond to analyze areas of sediment deposition and erosion, as shown in Figures 9.7 to 9.14 (CRI 2014). The cross sections present the bathymetry of the headpond for 1969 (CHS 1969) and 2014 (CRI 2014).

By comparing the recent and historical bathymetric data, it is possible to better understand where deposition and erosion have occurred in the headpond. The cross sections are indicative of a particular location and may not be representative of the entire reach.

Based on a comparison of the cross sections, changes at these sections have been minimal during the lifespan of the dam. The cross sections show little change between the years 2014 and 1969, with the exception of the cross section at Nackawic which shows deposition. At this location, deposition occurred at the inside of a river bend, a typical depositional feature in a watercourse. Deposition may be occurring in areas where data was not available, and some sediment fractions may have continued to move downstream past the headpond. Preliminary indications from the MAES work being conducted by the CRI are that while there is a thin film of poorly consolidated sediments throughout the headpond, there are few areas where sediment deposition greater than 30 cm thick has occurred.

Large reservoirs are capable of storing water for long periods of time and therefore are able to remove a large fraction of incoming sediments. Unlike large reservoirs, the Mactaquac headpond follows the river path (mainly a linear feature) with relatively small storage capacity when compared to its annual river flow input. Some incoming sediment fractions may therefore not have enough time to be deposited in the headpond and may spill over the dam or through the generating units. In this way, the headpond likely behaves differently than large reservoirs when considering the amount of sediment deposition.

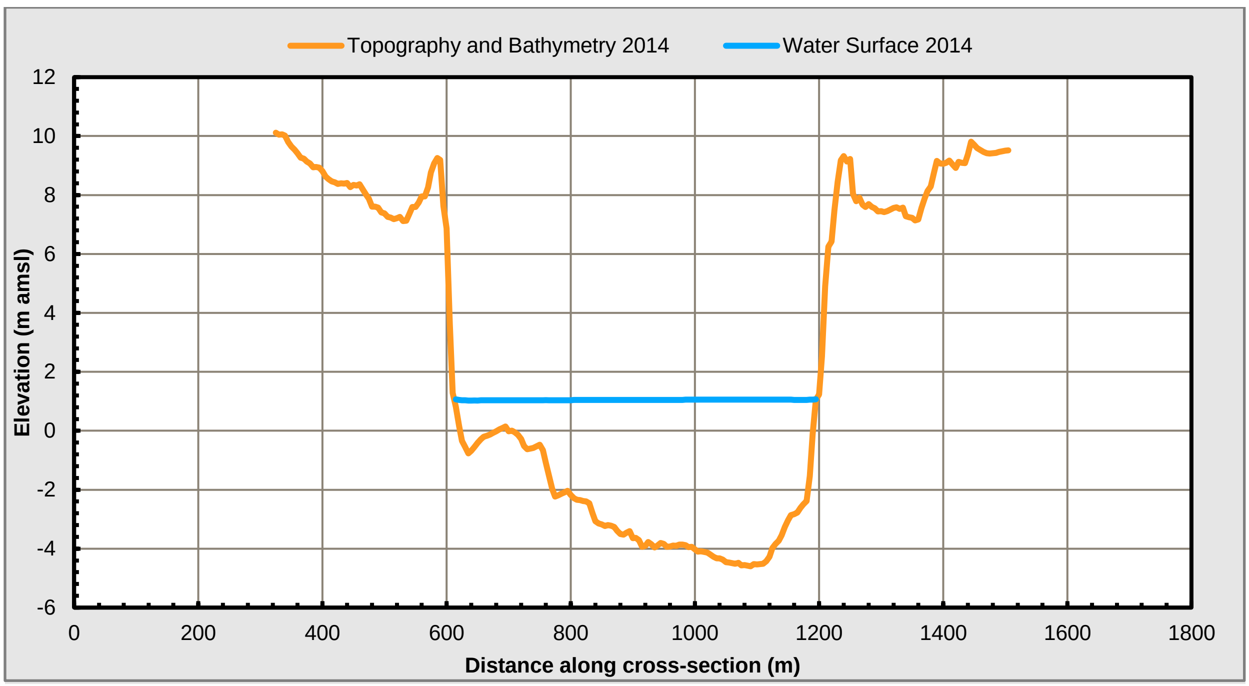


Figure 9.7 River Cross Section Located 19 km Downstream of MQGS at Fredericton

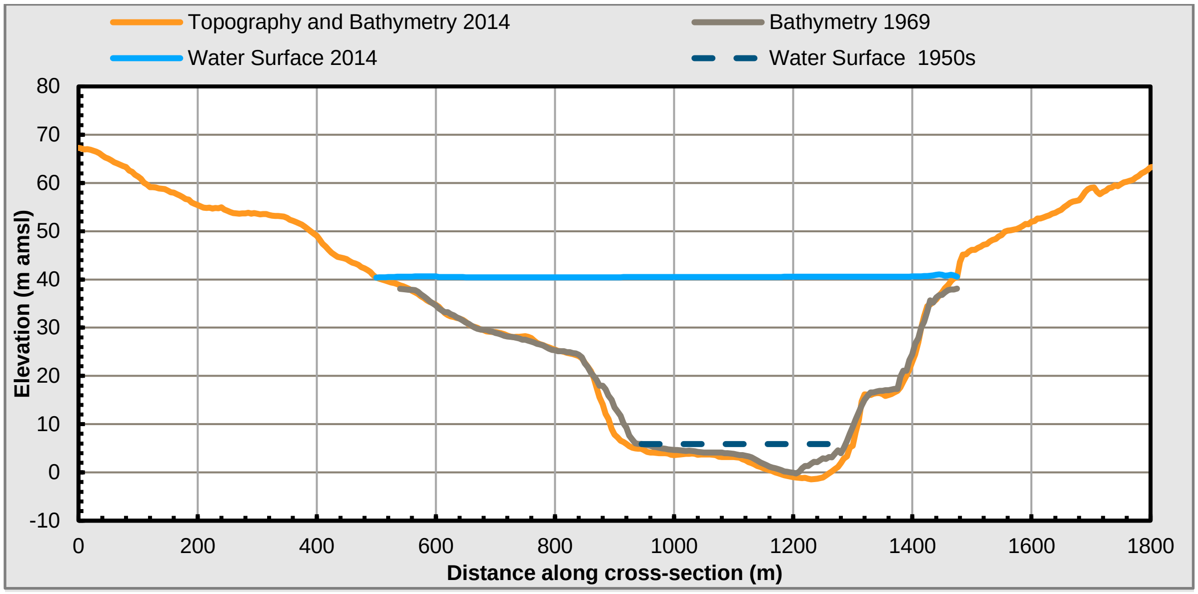


Figure 9.8 River Cross Section Located 1 km Upstream of MQGS at Mactaquac

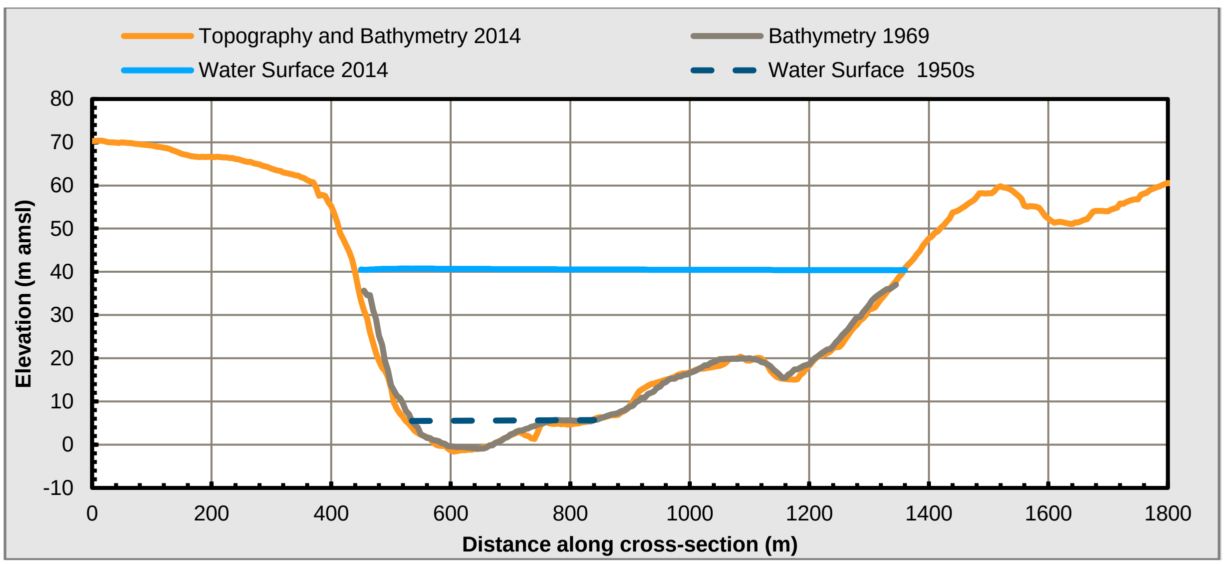


Figure 9.9 River Cross Section Located 8 km Upstream of MQGS at Upper Kingsclear

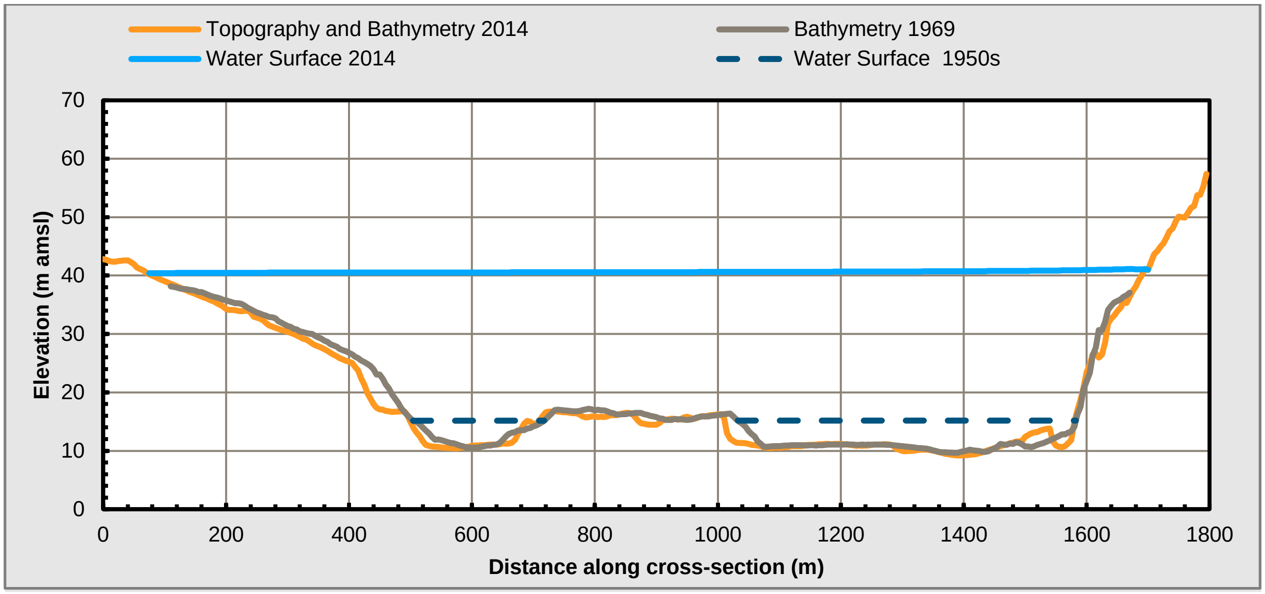


Figure 9.10 River Cross Section Located 22 km Upstream of MQGS at Granite Hill

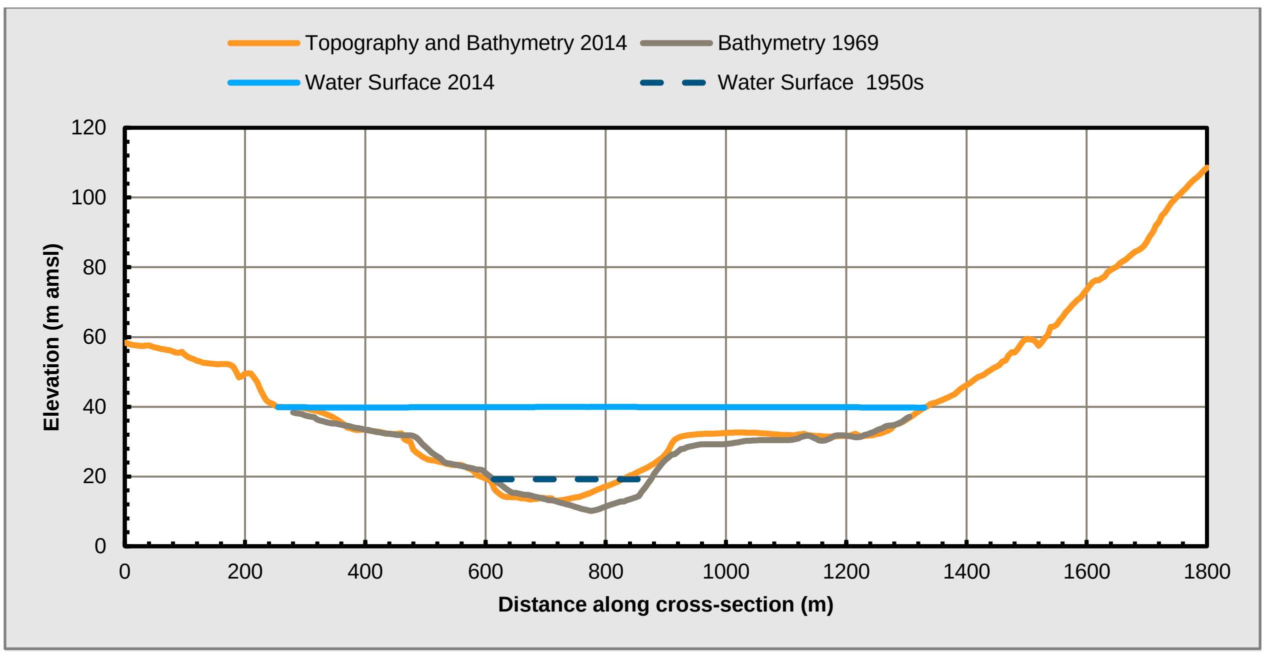


Figure 9.11 River Cross Section Located 37 km Upstream of MQGS at Nackawic

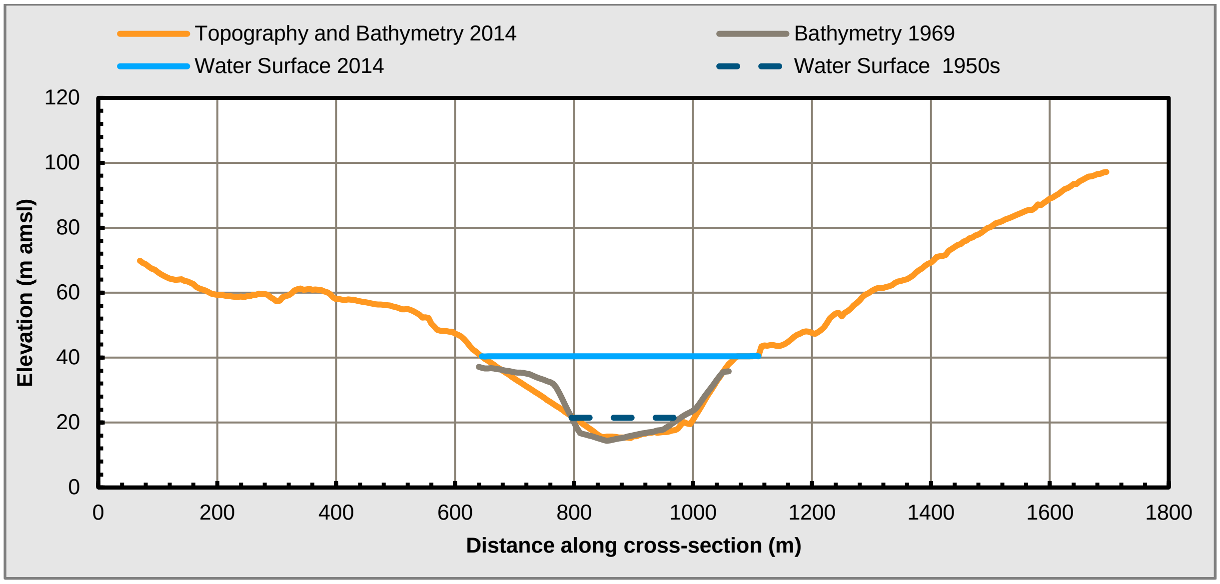


Figure 9.12 River Cross Section Located 49 km Upstream of MQGS at Mid-Southampton

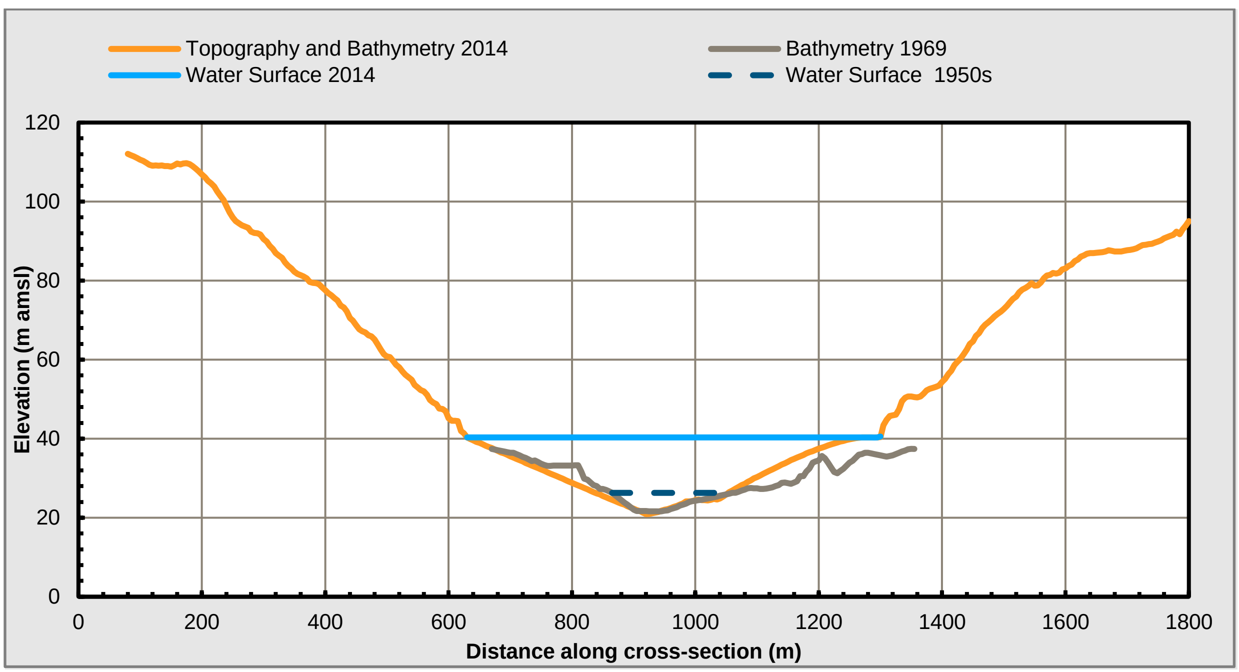


Figure 9.13 River Cross Section Located 62 km Upstream of MQGS at Meductic

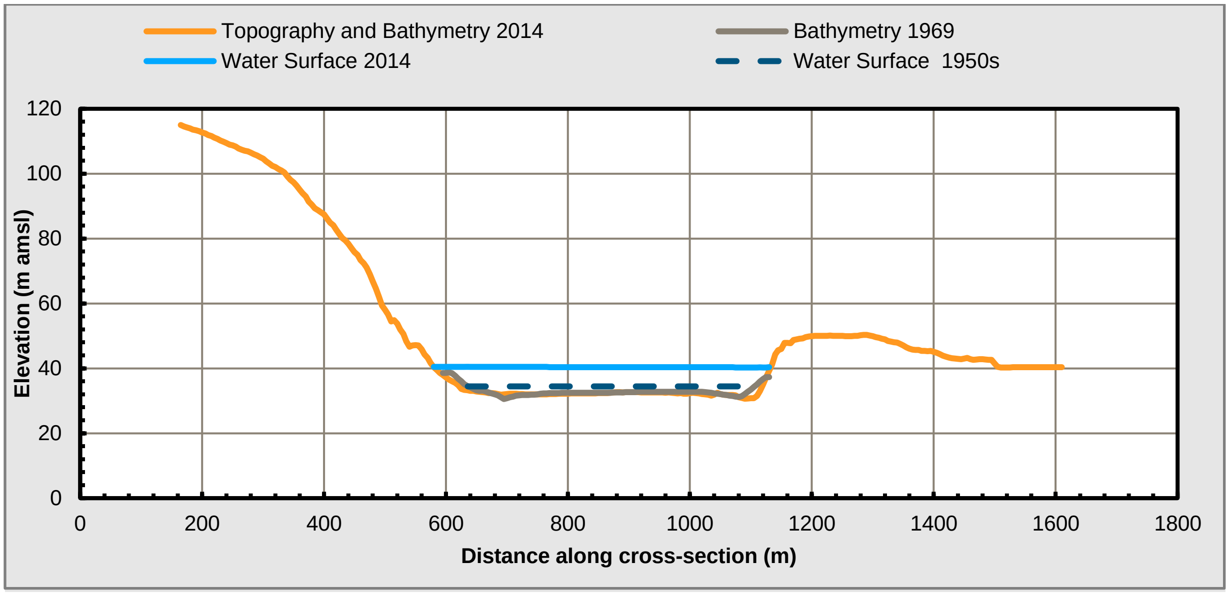


Figure 9.14 River Cross Section Located 81 km Upstream of MQGS at Woodstock

Surface Water Use

The St. John River and its tributaries supply water to several users within the LAA. Notable water uses include process water for the fish hatchery at the Department of Fisheries and Oceans Canada Mactaquac Biodiversity Facility in Kingsclear (1 km downstream of MQGS), potable water supply for the Mactaquac Provincial Park (at the Mactaquac stream confluence), and the potable water supply for the town of Oromocto/Canadian Forces Base Gagetown (37.5 km downstream of MQGS). Other municipal and industrial surface water intakes in the river are associated with irrigation and process water supply. Water is also pumped from various locations to fill tankers for fire suppression.

The Mactaquac headpond is heavily navigated, and some areas of the floodplains of both the river and tributaries are populated (*i.e.*, Fredericton). The river is actively used for recreational purposes.

Wastewater and Stormwater Outfalls

Much of the land bordering the St. John River and its tributaries is developed. The river receives discharged treated water from bordering municipalities within the LAA, including the town of Woodstock, Woodstock First Nation, the town of Nackawic, the city of Fredericton, and the town of Oromocto, among others. Businesses outside of the municipal service areas may have private outfalls that also discharge to the river. Agricultural operations do not require a permit to discharge into the river and therefore the existing conditions of these releases have not been included.

Upstream water users can influence the water quality of the St John River and the downstream water users may be affected by changes in flow regime if the outfall is regulated using an effluent discharge objective (EDO) that considers a specific mixing zone downstream of the outfall. Upstream water users include recreational users, municipal or provincial wastewater treatment outfalls, including the town of Woodstock, and Woodstock First Nation, and mill effluent outfalls from upstream operations. Downstream water users include municipal users such as the town of Oromocto and the City of Fredericton, provincial, and federal users, including the Canadian Forces Base Gagetown.

Surface Water Quality

The drainage area upstream of the headpond has a long history of farming, mainly cultivation of potatoes and poultry and hog farms. Farming contributes nutrients, sediments, and chemicals to nearby watercourses through soil erosion and discharges of effluent. Wastewater effluent discharges, including municipal wastewater treatment plants, are also potential sources of nutrients such as nitrogen and phosphorus.

CRI (2011) examined available water quality data sampled from the St. John River between 1950s and 2011. The results suggested that water quality in the river has improved since the 1960s. The improvement is largely attributed to improved treatment of municipal and industrial wastewaters (CRI 2011).

Water quality data for the St. John River are summarized in Table 9.7. These results are based on surface water quality data collected quarterly between 2003 and 2022 by NBDELG (2022b) at six water quality stations in the LAA. Samples were not collected in heavy precipitation events or during the peak spring freshet. A summer low river flow sample was intended to be collected each year. The statistics are presented for sampling locations upstream and downstream of MQGS.

The water quality data are compared to the Canadian Council of Ministers of the Environment Guidelines for the Protection of Freshwater Aquatic Life (CCME FAL) and the Health Canada Guidelines for Drinking Water Quality (GCDWQ; Health Canada 2022). Under existing conditions, some of the values exceeded guidelines, including aluminum, cadmium, copper, iron, pH, bacteria, and zinc. CRI (2011) found that bacterial levels (*e.g.*, *E.coli*) were highest in locations of wastewater discharges; however, these recent levels were considerably lower than in the 1960s before improvements in wastewater treatment were made. Upstream and downstream water quality was observed to have similar trends. When an exceedance occurred upstream, an exceedance of the same parameter occurred downstream of MQGS.

Long-term continuous records of water quality data are not available for the river. These data are representative of relatively recent river quality. Additional studies (*i.e.*, water temperature in the headpond and correlation with downstream temperatures) are recommended.

Table 9.6 Water Quality Data in the St. John River Collected Quarterly by NBDELG Between 2003 and 2022 – Upstream and Downstream of MQGS

Parameter	Units	Upstream				Downstream				CCME Protection of Aquatic Life	Guideline for Canadian Drinking Water Quality (GCDWQ)
		Mean	Min	Max	Total # of samples	Mean	Min	Max	Total # of samples		
Alkalinity	mg/L	44	24	75	286	38	21	53	147		
Aluminum	mg/L	0.09	0.01	2.84	288	0.10	0.02	0.38	154	Note C	
Ammonia, Total	mg/L	0.02	0.01	0.22	154	0.03	0.01	0.18	154	> 1	
Antimony	µg/L	1	1	1	154	1	1	1	154		6
Arsenic	µg/L	1	1	3	287	1	1	1	154	5	10
Cadmium	µg/L	0.09	0.01	2.00	288	0.11	0.05	**1.10**	154	0.04-0.16	5
Calcium	mg/L	16.8	4.8	35.6	288	14.8	4.3	21.1	154		
Chlorine	mg/L	3.96	0.86	11.80	288	4.11	1.72	12.90	154		
Chromium	µg/L	1.7	0.3	4.7	198	1.7	0.5	4.2	154		50
Colour	ACU	56.1	5.0	200.0	193	63.0	20.0	150.0	154		
Conductivity (Field)	µS/cm	115.1	53.3	216.0	288	83.2	36.5	122.0	95		
Conductivity (Lab)	µS/cm	120.3	96.0	148.4	12	101.6	40.7	142.0	154		
E_coli-MPN (MPN/100ml) ENV-Lab	MPN/100ml	45.0	45.0	45.0	45	45.0	45.0	45.0	45		
Dissolved Oxygen (Field)	mg/L	10.2	6.0	14.9	96	9.4	5.9	15.8	96		
E.coli	MPN/100ml	83	10	1440	113	68	10	2000	122		
Fluorine	mg/L	0.1	0.1	0.3	154	0.1	0.1	0.1	154		
Hardness	mg/L	50.5	14.6	103.0	154	44.2	10.1	63.6	154		
Iron	mg/L	0.2	0.1	**<u>1.1</u>**	154	0.2	0.0	**<u>0.7</u>**	154	0.3	0.3[AO]
Lead	µg/L	1	1	5	154	1	1	1	154	1-3.3	10

Table 9.6 Water Quality Data in the St. John River Collected Quarterly by NBDELG Between 2003 and 2022 – Upstream and Downstream of MQGS

Parameter	Units	Upstream				Downstream				CCME Protection of Aquatic Life	Guideline for Canadian Drinking Water Quality (GCDWQ)
		Mean	Min	Max	Total # of samples	Mean	Min	Max	Total # of samples		
Magnesium	mg/L	2.04	0.63	3.31	154	1.82	0.74	2.68	154		
Manganese	mg/L	0.03	0.01	0.30	154	0.03	0.01	0.09	154		50[AO]
Nickel	µg/L	5	3	6	154	5	3	5	154	25-97.75	
Nitrate	mg/L	0.0	0.0	0.1	154	0.0	0.0	0.1	154	13	
Nitrite	mg/L	0.23	0.05	1.90	154	0.16	0.05	0.52	154	60.00	
Nitrogen Oxides	mg/L	0.27	0.05	1.90	154	0.20	0.05	0.57	154		
Nitrogen, Total	mg/L	0.46	0.30	1.90	154	0.42	0.30	0.90	154		
pH (field)	pH	7.7	5.9	8.8	94	7.5	6.7	8.6	93	6.5-9	
pH (lab)	pH	7.8	6.5	8.5	154	7.7	6.9	8.6	154	6.5-9	
Phosphorus, Total	mg/L	0.02	0.01	0.09	154	0.02	0.01	0.06	154		
Potassium	mg/L	0.56	0.32	1.10	154	0.55	0.35	1.10	154		
Sodium	mg/L	3.05	1.56	6.47	154	3.50	1.99	7.54	154		200
Sulfate	mg/L	5.6	2.5	10.8	154	5.2	2.8	9.5	154	100	
Suspended Solids	mg/L	19	10	410	79	12	10	34	90		
Temperature	Celsius	15.7	0.0	29.9	107	16.5	4.2	25.9	111		
Total Organic Carbon	mg/L	7.4	4.2	12.9	154	7.9	5.2	13.4	154		

Table 9.6 Water Quality Data in the St. John River Collected Quarterly by NBDELG Between 2003 and 2022 – Upstream and Downstream of MQGS

Parameter	Units	Upstream				Downstream				CCME Protection of Aquatic Life	Guideline for Canadian Drinking Water Quality (GCDWQ)
		Mean	Min	Max	Total # of samples	Mean	Min	Max	Total # of samples		
Turbidity	NTU	5.5	0.3	441.0	154	3.4	0.4	52.8	154		
Zinc	µg/L	7.0	2.5	120.0	154	6.3	2.5	56.0	154	30	5,000[AO]

NOTE:

Samples were collected quarterly by NBDELG between 2003 and 2015. Samples were not collected in heavy precipitation events or during the peak of the spring freshet. A summer low flow sample was intended to be collected each year.

Bold and underline exceedance of GCDWQ, ***Bold and italics*** exceedance of FAL guidelines.

[c] - CCME FAL parameters were calculated based on the max and mean values for Aluminum (based on pH) and Cadmium, Copper, and Lead (based on hardness).

[AO] = Aesthetic Objectives

Various water quality and other aquatic data have been conducted by the CRI since 2013 as part of the MAES. In 2018, MAES released a report on the baseline water quality conditions in the St. John River (Dolson-Edge *et al.* 2018), which supports the water quality data collected by the NBDELG since the 2018 report presents similar baseline concentrations to the values reported by NBDELG.

Sediment Quality

Sediment quality is a good indicator of the environmental conditions of a watercourse. This is because substances that originate from agricultural and forestry activities and outfall discharge tend to adhere to sediments, especially to the smaller sediment fractions (Bednarek 2001). Once attached to sediments, these substances can be transported over long distances.

Chemical analyses of the sediment samples collected by CRI in 2014 were used to characterize conditions within the headpond. Samples were taken at 12 sites in the headpond in the fall of 2014, using a dredge to collect sediments, and from that a clean core tube was used to obtain a subsample of the top 5 cm (Kidd *et al.* 2015). Available laboratory results include concentrations of a suite of trace metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and chlorinated pesticides. A detailed description of the laboratory analysis and results for these parameters can be found in Kidd *et al.* (2015).

Preliminary data provided by CRI are summarized in Table 9.8 and compared to the CCME Sediment Quality Guidelines for the Protection of Aquatic Life Probable Effects Levels (PEL) (CCME 1998-2001) and the CCME Soil Quality Guidelines (SoQC) for the Protection of Environmental and Human Health for agricultural land use (CCME 1991-2009). The PEL represents the lower limit of the range of chemical concentrations that is frequently associated with adverse biological effects to biota that might be present in sediments and is applicable to sediments submerged in the headpond. The SoQC becomes applicable if sediments become deposited on shore and left as soils.

Table 9.7 Sediment Quality Data in the Headpond – Upstream of MQGS

	Parameter	Units	Upstream			CCME Sediment Quality Guidelines of Aquatic Life (PEL)	CCME SoQC for Protection of Environmental and Human Health
			Minimum	Maximum	No. of samples		
Trace Metals	Aluminum	mg/kg	16,540	39,080	20		
	Arsenic	mg/kg	6	***22***	20	17	12
	Cadmium	mg/kg	0.08	0.24	20	3.5	1.4
	Chromium	mg/kg	29.7	61.1	20	90	64
	Cobalt	mg/kg	9.3	18.6	20		40
	Copper	mg/kg	6.8	25.2	20	197	63
	Iron	mg/kg	21,600	45,230	20		
	Lanthanum	mg/kg	14.7	31.5	20		
	Magnesium	mg/kg	6,202	9,901	20		
	Manganese	mg/kg	484	4,207	20		
	Mercury (Total)	µg/kg	16	120	20	486	6,600
	Nickel	mg/kg	27.8	***52.5***	20		50
	Phosphorus	mg/kg	445	1563	20		
	Lead	mg/kg	8.4	20.4	20	91.3	70
	Rubidium	mg/kg	20.1	63.7	20		
	Sulphur	mg/kg	74	908	20		
	Strontium	mg/kg	16.8	45.7	20		
	Titanium	mg/kg	1.3	2.11	20		
	Vanadium	mg/kg	46.4	89.9	20		130
	Zinc	mg/kg	58	116	20	315	200
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthylene	mg/kg	0.005	0.028	20	0.128	
	Anthracene	mg/kg	0.005	0.043	20	0.245	
	Benz(a)anthracene	mg/kg	0.005	0.094	20	0.385	
	Benzo(a)pyrene	mg/kg	0.005	0.083	20	0.782	
	Benzo(b)fluoranthene	mg/kg	0.005	0.107	20		
	Benzo(g,h,i)perylene	mg/kg	0.005	0.045	20		
	Benzo(k)fluoranthene	mg/kg	0.005	0.087	20		
	Chrysene	mg/kg	0.03	0.09	20	0.862	
	Fluoranthene	mg/kg	0.041	0.174	20	2.355	
	Fluorene	mg/kg	0.005	0.018	20	0.144	
	Indeno(1,2,3-cd)pyrene	mg/kg	0.005	0.088	20		
	Phenanthrene	mg/kg	0.025	0.091	20	0.515	
	Pyrene	mg/kg	0.041	0.141	20	0.875	
	Total Polycyclic Aromatic Hydrocarbons	mg/kg	0.173	0.978	20		

Table 9.7 Sediment Quality Data in the Headpond – Upstream of MQGS

	Parameter	Units	Upstream			CCME Sediment Quality Guidelines of Aquatic Life (PEL)	CCME SoQC for Protection of Environmental and Human Health
			Minimum	Maximum	No. of samples		
Chlorinated Pesticides and Total Polychlorinated Biphenyls	Aldrin	µg/kg	0.2[a]	0.3	20		
	Hexachlorobenzene	µg/kg	0.19[a]	0.24	20		50
	Methoxychlor	µg/kg	1.1	6.0	20		
	Nonachlor (Total)	µg/kg	0.1[a]	0.4	20		
	Chlordane (Total)	µg/kg	0.17[a]	0.68	20	8.87	4.5
	Heptachlor Epoxide (Isomer B)	µg/kg	< DL	< DL	20	2.74	
	Dieldrin	µg/kg	< DL	0.4	20	6.67	
	DDE (Dichlorodiphenyldichloroethylene) (Total)	µg/kg	2.95	**<u>29.5</u>**	20	6.75	
	DDD (Dichlorodiphenyldichloroethane) (Total)	µg/kg	1.14	**<u>16.3</u>**	20	8.51	
	DDT (dichlorodiphenyltrichloroethane + DDD+DDE) (Total)	µg/kg	4.23	**<u>34.8</u>**	20	4.77	700
	Endosulfan (Total)	µg/kg	0.2[a]	4.0	20		
	Endrin	µg/kg	0.39[a]	1.31	20	62.4	
	γ-HCH (Lindane)	µg/kg	0.13[a]	0.26	20	1.38	10
	PCBs (Total)	µg/kg	0.13[a]	0.52	20	277	500
Organics	Organic Carbon	%	0.2	3.9	20		
	Kjeldahl Nitrogen	mg/kg	340	3,760	20		
	Phosphorus	mg/kg	430	1,490	20		

Notes:
Data from Kidd *et al*. (2015)
A value in **<u>bold and underline</u>** indicates a value in excess of the CCME PEL guidelines.
A value in ***<u>bold italics and underline</u>*** indicates a value in excess of both the CCME PEL and CCME SoQG guidelines.
(ND) = Not detected, reported value half of detection limit
mg/kg = milligrams per kilogram (dry weight)
µg/kg = micrograms per kilogram (dry weight)
DL = detection limit, value was not reported for that parameter (Kidd *et al.* 2015)
[a] = the minimum result is reported, however the minimum value is less than the unknown detection limit
SoQC = guidelines assuming agricultural land use (most conservative).

The results presented in a report by Kidd *et al.* (2015) show values in excess of guideline values for arsenic, nickel, and DDT compounds for the 20 sediment samples collected in the headpond. All other parameters are below guidelines. The arsenic exceedance (maximum of 22.38 mg/kg, guideline of 12 mg/kg) is likely due to naturally occurring geological conditions in New Brunswick (NBENV 2008). CRI (2011) reports arsenic concentrations below CCME sediment guidelines for the protection of freshwater aquatic life. Sediment samples with exceedances were measured in locations near MQGS; however, they appear to have no particular distribution pattern along the headpond. Results for nickel were consistently above the CCME Soil Quality Guidelines, which is consistent with nickel concentrations in agricultural soils reported by Loro (1996).

Preliminary analyses of PAHs indicated the presence of several constituents found at different sites below sediment quality guidelines. Kidd *et al.* (2015) indicate that since no other data regarding PAHs are known to be available, they were uncertain if these PAHs concentrations are typical for the St. John River.

Preliminary analyses of PCBs show that the concentrations of individual PCB components were not detected for most samples. Detected concentrations of PCBs were below sediment quality guidelines. Chlorinated pesticides were found in sediment at various sampling sites. Out of the individual chlorinated pesticides that were analyzed, values of Total DDD, Total DDT, and Total DDE were above sediment quality guidelines.

Kidd *et al.* (2015) suggest that results showed similar sediment contaminant concentrations at most sites in the headpond. The lowest concentrations were found at a site farthest upstream, corresponding with lower organic carbon and concentrations of nitrogen and phosphorus than other locations of the headpond. The report suggests that some of the spatial variability in contaminants was likely due to the differences in sediment composition. The report did not indicate any sediment chemistry focal points related to human activities in the headpond based on the interim sampling completed in 2014.

9.3.2.2 Groundwater

Aquifer Characteristics

Groundwater is important as a water resource in New Brunswick, with more than 75% of the population relying on groundwater as a source of drinking water (Statistics Canada 2010). Groundwater from drilled or screened wells is used for domestic, agricultural, municipal, commercial, institutional, and industrial purposes. Groundwater is most often preferred over surface water as a source of drinking water as it generally can be used with little to no treatment.

Water Wells

Groundwater in the vicinity of the headpond is used by both rural and urban users. Rural users typically extract groundwater from wells completed in bedrock, with an average well depth of 62.6 m below ground surface (bgs) (NBDELG 2022a). Based on data provided by NBDELG, about 10% of these wells are shallow (*i.e*., less than 30 m deep), and have an average safe yield of 290 m^3/d. The average static groundwater level (*i.e.*, the water level when there is no pumping of the well) within the LAA is 9.4 m bgs.

Five major users of groundwater were identified in the area surrounding the Project, including the town of Nackawic, Jolly Farmer Products Inc. Woodstock First Nation, the Town of Woodstock, and Kingsclear First Nation. Of these, several have wells completed in sand and gravel aquifers in connection with the headpond, and several others are completed in bedrock aquifers.

According to the NBDELG's OWLs database, there are 37 water wells within 100 m of the PDA, with 35 of these used for drinking water (NBDELG 2022a). The remaining two wells were exploratory and completed in 2018, and are not used as drinking water wells. A total of 24 of the water wells are domestic and were drilled between 1994 and 2021. Ten water wells are municipal, drilled between 2019 and 2021. One well is listed as "Other" on the database and was completed in 2016. It is important to note that the OWLs database only contains information for wells drilled after 1994; therefore, it is possible that there are presently more than 37 wells within 100 m of the PDA.

Groundwater Quality

In general, the groundwater quality within the area of review is good and is described as a hard, slightly alkaline, calcium-chloride water type with low dissolved solids. Some wells have reported concentrations of some metals that naturally exceed the respective health-based Guidelines for Canadian Drinking Water Quality (GCDWQ) (Health Canada 2022). Water from these wells requires treatment for use as a drinking water supply. Most wells have concentrations of iron and manganese that exceed respective GCDWQ aesthetic objectives, which is common in New Brunswick because of the local geology (NBENV 2008). Presence of *E. coli* and total coliform bacteria counts were noted in some wells. The presence of bacteria could be due to poor well construction, particularly casing integrity, or depending on the timing of the sample collection, they could be remnants of the drilling and well construction process.

9.4 EFFECTS ASSESSMENT

9.4.1 Assessment Criteria

9.4.1.1 Residual Effects Characterization

Table 9.9 presents definitions for the characterization of residual environmental effects on water resources. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not possible.

Table 9.8 Characterization of Residual Effects on Water Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual water resources effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to water resources relative to baseline **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to water resources relative to baseline

Table 9.8 Characterization of Residual Effects on Water Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in water quality and quantity relative to existing conditions.	**Negligible –** no measurable change to water quality/quantity relative to baseline **Low** – a measurable change to water quality/quantity is detectable and within the normal variability that would be expected (baseline) **Moderate** – a measurable change to water quality/quantity occurs that is considered elevated above baseline and within acceptable limits **High –** a measurable change to water quality/quantity occurs that is considered elevated above acceptable limits or regulatory objectives
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the Project development area **LAA –** residual effects extend into the LAA
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term –** residual effect extends for less than 1 year **Medium term –** residual effect extends through the construction phase **Long term –** residual effect extends through the operation phase **Permanent –** recovery to baseline conditions unlikely
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not applicable –** effect does not occur during critical life stage or timing does not affect the VC **Applicable –** effect occurs during a critical life stage
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event –** occurs only once **Multiple irregular event –** occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

9.4.1.2 Significance Definition

A significant adverse residual effect on water resources is defined as one that:

- Results in a reduction in water quantity below established maintenance flow/in-stream flow requirements (*i.e.*, 68 m^3/s)
- Results in changes to the flow regime that cause erosion of the riverbed or its banks to such an extent that they cannot be mitigated or remediated by engineered erosion controls
- Causes a deterioration in water quality from an existing and otherwise adequate surface water supply to the point where it is outside the range of existing baseline variability, cannot meet, CCME FAL or GCDWQ for two consecutive monthly sampling events
- Causes a deterioration in water quality from an existing and otherwise adequate groundwater supply to the point where it cannot meet the GCDWQ for two consecutive monthly sampling events
- Increases suspended sediments to levels exceeding the CCME FAL guideline for total suspended solids (TSS) for two consecutive monthly sampling events

9.4.2 Potential Project Interactions with Water Resources

Activities and components could potentially interact with water resources to result in adverse environmental effects on the water resources. In consideration of these potential interactions, the assessment of Project-related environmental effects on water resources is therefore focused on the potential environmental effects listed in Table 9.10. These potential environmental effects will be assessed in consideration of specific measurable parameters, also listed in Table 9.10.

Table 9.9 Potential Environmental Effects and Measurable Parameters for Water Resources

Potential Environmental Effects	Effects Pathways	Measurable Parameters
Change in surface water flow regime	• Work will occur on one pier at a time, requiring the gates to that pier to be shut down and flow re-routed to other sections of the dam.	• Water flow pattern changes (Interaction of change to water levels, depths, velocities) • Safety/navigation in the headpond/river • Flow retention and management • Sediment transport and scour potential
Change in surface water or sediment quality	• Grout will be used to repair the dam structure in an isolated work environment (cofferdam). • Installation of cofferdam on the downstream end of MQGS may disturb sediment at the riverbed. • Potential increase of TSS levels to upstream and/or downstream surface water users.	• Water and sediment quality • Assimilative capacity/mixing characteristics for existing effluent discharges

Table 9.9 Potential Environmental Effects and Measurable Parameters for Water Resources

Potential Environmental Effects	Effects Pathways	Measurable Parameters
Change in groundwater quality/quantity	• Potential water level fluctuations in headpond may affect quality and quantity of adjacent groundwater wells. • Use of cofferdams to hydraulically isolate sections of the dam may result in increased groundwater discharge within the isolated zone.	• Groundwater quality • Aquifer yield • Dewatering of hydraulically isolated zone

Table 9.11 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 9.10 Potential Interactions between Physical Activities and Water Resources

Phase	Change in Surface Water Flow Regime	Change in Surface Water or Sediment Quality	Change in Groundwater Quality/Quantity
Construction			
Site preparation	-	✓	-
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	-	✓	-
Isolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	-	-	-
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	-	-	-
Shut down of power units	-	-	-
Fish passage		-	-
Transportation (*powerhouse: transportation of equipment)*	-	-	-
Employment and expenditure	-	-	-

Table 9.10 Potential Interactions between Physical Activities and Water Resources

Phase	Change in Surface Water Flow Regime	Change in Surface Water or Sediment Quality	Change in Groundwater Quality/Quantity
Operation and Maintenance			
Operation of the MQGS	-	-	-
Maintenance of the MQGS	-	-	-
Fish passage	-	-	-

Notes:
✓ = Potential interaction
– = No interaction

9.4.2.1 Construction

As the MQGS is run-of-river and functions through the use of six spillways and associated gate control structures, the proposed approach to work on one generating unit at a time means that the MQGS will manage flows through the other five units/gate control structures during construction. The use of five spillway/gate control structures is within the normal operating conditions of the dam, as control gates and turbines presently need to be routinely taken offline for maintenance and repair. Flows will remain within normal operating limits (*i.e*., 2,265 to 5,663 m^3/s) and the overall daily flow rate will remain within normal operating levels. Water levels in the headpond will not exceed the maximum retention elevation limit of 40.5 m (133 ft), therefore navigation within the headpond for upstream users is not anticipated to be affected. Maintenance flows are expected to be maintained through the remaining spillways with no effect to fish passage in the downstream habitat. As such, no changes to surface water quantity are expected as a result of construction of the Project and therefore are not discussed further.

With respect to wastewater/stormwater outfalls and surface water uses, construction activities associated with the refurbishment of the MQGS are not anticipated to alter flow regimes, or cause increase in TSS levels to users upstream or downstream of the station. The MQGS will operate within normal operating limits, as mentioned above, therefore no changes to surface water use and wastewater/stormwater outfalls are expected as a result of construction of the project and are not discussed further.

Construction activities associated with the refurbishment of the existing MQGS structures are not anticipated to interact with groundwater quality, as there will be no blasting of hard bedrock that could increase the turbidity in a water supply well. Up to two new potable wells will be installed within the PDA to supply potable water during construction; however, they are not expected to affect groundwater quality. Wells will be drilled by a licensed well driller and constructed per requirements outlined in the *Water Well Regulation – Clean Water Act.* At the end of useful service, wells will be appropriately decommissioned following the Guidelines for the Decommissioning (abandonment) of Groundwater Wells and Boreholes (NBDELG 2021). Therefore, groundwater users in the area are not anticipated to notice qualitative changes in their well water while construction is ongoing. Changes to groundwater quality are not expected during construction and therefore are not discussed further.

The quantity of available groundwater could change during strong fluctuations in the level of the headpond. However, construction activities of the Project are not anticipated to result in changes to the level of water in the headpond in relation to the current operating conditions of the MQGS. Similarly, the refurbishment of the existing structures is not anticipated to interact with groundwater quantity, given the limited physical change expected to those facilities. The new potable wells on the PDA are not expected to change the quantity of water available for groundwater users. Water usage is not anticipated to exceed 50 m^3/day. If this usage is greater than anticipated, well installation will be subject to a Water Supply Source Assessment, following the Water Supply Source Assessment Guidelines (NBDELG 2017). Changes to groundwater quantity during construction are not expected and are therefore not discussed further.

9.4.2.2 Operation and Maintenance

Operation and maintenance activities associated with the MQGS are not expected to change the surface water flow regime or affect groundwater quality or quantity. Once construction activities are complete, all six generating units will be operational, and the MQGS will resume operation as it does currently as a run-of-river system. Although the operation of the rehabilitated MQGS will use water from the river, it is the continued operation of the shared facilities (*i.e.*, headpond and spillway) that will dictate the influence on the surface water regime. Maintenance activities of repaired facilities are not expected to change from maintenance activities conducted at the existing MQGS. Therefore, there are no environmental effects on these water resources arising from operation and maintenance activities associated with the Project; they are therefore not assessed further.

9.4.2.3 Potential Effects to Water Resources During Construction

In the absence of mitigation, the construction of the Project has the potential to interact with water resources during construction which could result in changes to surface water or sediment quality. These potential interactions are discussed in further detail below.

Change in Surface Water or Sediment Quality

Reconstruction of the intake channel, powerhouse, and downstream components will require both isolated work areas and in-water work. Construction of these Project components will result in some in-stream sedimentation, even after implementation of appropriate erosion and sediment control measures. It would be unreasonable to assume that erosion and sediment control measures during construction would not result in some minor and short-term in-stream sedimentation.

9.4.2.4 Potential Effects to Water Resources During Operation and Maintenance

As noted previously, there are no potential environmental effects expected from the Project on water resources during operation and maintenance. They are not discussed further.

9.4.3 Mitigation for Water Resources

Interactions between Project activities and water resources will be managed by application of various mitigation measures. The following mitigation measures specific to water resources have been identified for this Project.

- A Project-specific Environmental Management Plan (PSEMP) will be developed and followed that outlines construction best management practices, spill management, and erosion and sediment control. All employees and contractors working on the Project will be trained on the PSEMP prior to commencing work.
- Response procedures related to the temporary control of releases of deleterious substances (should they occur as unplanned events) will be outlined in an Emergency Response Plan that will be part of the PSEMP, including spill prevention measures, erosion prevention and sediment control failure, hazardous material spills, and waste management.
- Erosion and sedimentation control (ESC) measures will be implemented prior to construction and maintained throughout construction until the area is stabilized. ESC measures will be inspected regularly and repaired and maintained as warranted, with specific emphasis on water-based control structures with capacity to withstand wind, flow, and hydrostatic pressures. In-stream ESC structures, such as turbidity curtains, should be sized based on maximum anticipated flood flows through the MQGS.
- Construction material (*e.g.,* grout, concrete) placed in or next to watercourses will be free of debris, fine silt, and sand (to the extent possible based on available borrow sources) and chemical contaminants to prevent sediment particles from entering the watercourse.
- For in-water work and work in the isolated zones, concrete repairs and grouting shall occur behind a permeable fabric turbidity curtain sized based on maximum anticipated flows through the MQGS, or carbon dioxide sparging may be implemented in-stream downstream of the construction work to mitigate pH levels within the St. John River (DRISI 2016).
- Dewatering of excavated areas will control release of sediment-laden water (*e.g.*, filtration through vegetation or engineered erosion control devices). Dewatering will also be monitored for both TSS and pH, and sample concentrations shall remain within CCME FAL guidelines.
- Where feasible, in-stream work areas below the water line will be isolated from the river using cofferdams to work in the dry thus reducing the risk for sediment to enter the river and contamination of water through contact with wet or curing concrete.
- Water pumped out of the site to create dry conditions for construction, after cofferdams have been installed, will be monitored for quality to be consistent with suspended sediment and pH limits specified by regulatory approvals and check effectiveness of hydraulic isolation and erosion and sedimentation control measures.

9.4.4 Characterization for Residual Project Environmental Interactions with Water Resources

9.4.4.1 Construction

Based on sediment particle sizes collected by the CRI in 2015, sediment transport calculations were performed to determine the settling time and distance for D50 particles upstream of the MQGS (13 µm) if the sediment was disturbed during construction in the absence of mitigation measures (*i.e.*, cofferdam hydraulic isolation, turbidity curtains). The time to settle the D50 particles upstream of the dam was determined to be approximately 13 hours and would travel approximately 164 km downstream. The installation of cofferdams is expected to disturb sediment at the stream bed and affect a sediment volume of approximately 90 m^3 per pier, assuming a cofferdam of 30 m in length and 3 m in width is installed at each pier. Based on the affected area, the cofferdam installation is estimated to disturb approximately 238,500 kg of sediment over the installation period. Assuming the installation period is 1 week, the cofferdam installation may cause an increase of 0.485 mg/L of TSS in the stream. The CCME FAL limit for TSS concentrations is a maximum increase of 5 mg/L from background levels over a period lasting between 24 hours and 30 days. As TSS levels are not expected to exceed the CCME FAL guidelines, no residual environmental effects due to stream bed disturbance are anticipated. Mitigation measures such as turbidity curtains are recommended to reduce and prevent the transport of suspended sediment downstream of MQGS.

The isolated work in the dry and in-water work will require the use of Tremie concrete (*i.e.*, underwater concrete operations) and grout. As concrete and grout can increase pH in water above the CCME FAL limit of 8.5, mitigation measures should be implemented. The use of hydraulic isolation and dewatering will mitigate the contact of river water from wet or newly curing concrete, thus addressing this concern (DRISI 2016, DFO 1983, DFO 1995). Water quality of the St. John River is expected to remain within the bounds of existing baseline variability conditions during the Construction phase of the Project with the implementation of mitigation measures.

The residual environmental effects of construction of the Project on water resources are predicted to be adverse in direction as there will be a potential change in surface water quality as a result. Overall, the magnitude of residual environmental effects is predicted to be low as water quality parameters are anticipated to remain near baseline levels. These changes will be primarily within the LAA. The duration of environmental effects on water resources will be medium term, (*i.e.*, lasting longer than 1 year), extending throughout the construction phase, and predicted to occur as multiple irregular events during the isolation of piers using cofferdams. The timing is not applicable as the timing of the project would not change the effects on the VC. The environmental and socioeconomic context is characterized as undisturbed as this environment is already affected by the existing MQGS, and the construction of this Project is not anticipated to change that context.

9.4.4.2 Operation and Maintenance

As noted previously, there are no residual environmental effects expected from the Project on water resources during operation and maintenance. They are not discussed further.

9.4.5 Summary

Table 9.12 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Water Resources.

Table 9.11 Project Residual Effects on Water Resources

Residual Effect	Residual Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Surface Water Flow Regime	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Change in Surface Water or Sediment Quality	C	A	L	LAA	MT	NA	IR	R/I	D
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Change in Groundwater Quality/Quantity	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

KEY:
See Table 9.9 for detailed definitions

Project Phase
C: Construction
O: Operation and maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

9.5 DETERMINATION OF SIGNIFICANCE

With the application of proposed mitigation and environmental protection measures, the residual environmental effects on water resources (including water quality and water quantity) from Project activities and components during all phases of the Project are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general environmental effects of in-water construction activities on surface water and groundwater, the recognized quantification of potential effects such as sedimentation, and the effectiveness of mitigation measures discussed in Section 9.4.3, such as use of cofferdams and hydraulic isolation.

9.6 FOLLOW UP AND MONITORING

Follow-up and monitoring are intended to verify the accuracy of predictions made during the environmental impact assessment (EIA) registration, to assess the implementation and effectiveness of mitigation and the nature of the residual effects, and to manage adaptively, if required. Compliance monitoring will be conducted to confirm that mitigation measures are properly implemented. Should an unexpected deterioration of the environment be observed as part of follow-up and/or monitoring, intervention mechanisms will include the adaptive management process. This may include an investigation of the cause of the deterioration and identification of existing and/or new mitigation measures to be implemented to address it.

Follow-up and monitoring plans to be implemented for the water resources include:

- TSS, pH, and water quality monitoring during the construction period, specifically during installation, operation, and dismantling of cofferdams to ensure sediment transport is minimized and wet/curing concrete and grout do not contaminate dewatering discharge back to the River.

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10.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON THE AQUATIC ENVIRONMENT

The assessment of potential environmental effects of the Project on the aquatic environment is provided in this chapter.

For the purposes of this valued component (VC), the aquatic environment includes the St. John River and its tributaries within the vicinity of the Mactaquac Generating Station (MQGS) which provides habitat and food for fish, benthic communities, aquatic plants, and other aquatic species.

10.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

The aquatic environment has been assessed as a VC because it provides ecological, cultural, recreational, and economic value to the public, Indigenous groups, local businesses, and government agencies. The aquatic environment is important for supporting fisheries resources, fish that support those fisheries, and providing food for other organisms (*e.g.*, birds and mammals). The St. John River (Wolastoq) drainage basin supports a diverse aquatic community that includes various species of fishes, algae, plants, and invertebrates (CRI 2011). The St. John River is of particular social and economic importance to the people of New Brunswick and local Indigenous communities. Fish are valued by resource users and are protected by federal and provincial legislation and policies in Canada and New Brunswick (NB).

The aquatic environment VC is also linked to:

- Water resources (Chapter 9) – changes in water resource use have the potential to affect the aquatic environment as well as riparian wetland habitat
- Indigenous communities (Chapter 12) – changes in the aquatic environment have the potential to affect the current use of land and resources for traditional purposes by Indigenous groups (*i.e.*, for fishing)
- Socioeconomic conditions (Chapter 14) – changes in the aquatic environment can affect the availability of fish for consumption as a country food, which can indirectly affect the health and economic well-being of members of the public

10.2 SCOPE OF ASSESSMENT FOR THE AQUATIC ENVIRONMENT

For the purposes of this assessment, the aquatic environment VC includes fish and fish habitat and primary and secondary productivity. Fish and fish habitat are defined under the federal *Fisheries Act* as follows:

- "*Fish includes: (i) parts of fish, (ii) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and (iii) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals*"

- "*Fish habitat means waters frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas"*

Primary and secondary productivity are also included as they provide sources of food for fish and are vital to fish to carry out their life processes. Primary productivity is the production of chemical energy and conversion into organic compounds by living organisms (*e.g*., photosynthesis and phytoplankton growth), and forms the base of the aquatic food web (*e.g.*, algae, periphyton, phytoplankton, zooplankton, aquatic macrophytes). Secondary productivity is the production of animal tissue from organic matter by organisms that cannot produce their own food (*e.g.*, benthic invertebrates). Benthic invertebrate communities provide a major food resource for fish and can be used as ecological indicators of environmental change such as pollution.

The aquatic environment can be affected by Project-related changes in surface water resources (Chapter 10) through localized changes in flow which may result in changes in fish habitat (*i.e.*, water quality, velocity, depth, channel slope, sediment transport, and ice flow regime) and fish passage. Therefore, residual effects predicted for surface water were also used to inform potential Project effects on the aquatic environment.

10.2.1 Regulatory Context

In addition to New Brunswick's *Environmental Impact Assessment Regulation*, the Project is subject to other federal and provincial legislation, policies, and guidance. This section identifies the primary regulatory requirements and policies which influence the scope of the assessment on fish and fish habitat and govern the management and protection of fish and fish habitat in Canada and New Brunswick.

10.2.1.1 Federal

Fisheries Act

The federal *Fisheries Act* is administered primarily by the Department of Fisheries and Oceans Canada (DFO) with some provisions administered by Environment and Climate Change Canada (ECCC). The *Fisheries Act* protects fish and fish habitat and addresses national interests in marine and fresh waters with the goal of protecting the long-term sustainability of aquatic resources. The *Fisheries Act* includes prohibitions against works, undertakings or activities that result in the harmful alteration, disruption, or destruction (HADD) of fish habitat (Section 35(1)). HADD of fish habitat is defined under the *Fisheries Act* policies as "*any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat's capacity to support one or more life processes of fish*." The *Fisheries Act* also prohibits the carrying out of a work, undertaking, or activity, other than fishing, that results in the death of fish (Section 34.4(1)).

In both cases, works can be approved by and carried on in accordance with conditions established by the Minister of Fisheries, Oceans and the Canadian Coast Guard (the Fisheries Minister). Any such work requires an authorization (Section 35(2)(b) and Section 34.4(2)(b)) and with an appropriate offsetting of residual adverse effects after avoidance and mitigation steps have been taken.

Section 34.3(2) provides provisions for maintaining adequate flow and respecting the free passage of fish.

Under Section 36 of the *Fisheries Act*, "*no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish*" without authorization.

Species at Risk Act

The federal *Species at Risk Act* (*SARA*) provides protection for species at risk (SAR) in Canada. The legislation provides a framework to facilitate recovery of species listed as Threatened, Endangered, or Extirpated, and to prevent species listed as Special Concern from becoming Threatened or Endangered. Endangered or Threatened SAR on Schedule 1 and their habitats are protected under *SARA*, which prohibits: 1) the killing, harming, or harassing of Endangered or Threatened SAR (Sections 32 and 36), and 2) the destruction of critical habitat of an Endangered or Threatened SAR (Sections 58, 60, and 61). Species listed as Special Concern on Schedule 1 of *SARA*, species listed on Schedule 2 and 3, and species with no *SARA* status are not subject to these prohibitions.

10.2.1.2 Provincial

New Brunswick *Clean Water Act*

The New Brunswick *Clean Water Act* (90-80) indirectly protects fish and fish habitat through the *Watercourse and Wetland Alteration Regulation* (WAWA). The WAWA regulation requires a permit for any activity that will result in a temporary or permanent change to a watercourse or wetland or changes within 30 m of a watercourse or wetland.

New Brunswick *Clean Environment Act*

The New Brunswick *Clean Environment Act* regulates water quality within the province through the *Water Quality Regulation*. The Minister of the Environment and Local Government (NBDELG) may grant approvals under the *Water Quality Regulation* for activities that will result in releases of pollutants or contaminants to the waters of the province. The Minister may also set water quality limits within the Approval to Operate for a facility where any changes to water quality may occur.

New Brunswick *Fish and Wildlife Act*

The New Brunswick *Fish and Wildlife Act* regulates the recreational capture of fish (angling) within the province of New Brunswick. The Act is administered and enforced by the New Brunswick Department of Natural Resources and Energy Development (NBDNRED) through the *General Angling Regulation*. The Act and Regulation sets timing for fishing, and size and bag limits for both resident and non-resident anglers. Recreational Fishery Areas (RFAs), the species that can be collected in the RFAs, as well as the specific requirements for anglers, are identified and outlined in the "Fish NB: Angling Regulations Guidebook" (Province of New Brunswick 2022) which is updated each year.

New Brunswick *Species at Risk Act*

The New Brunswick *Species at Risk Act* (NB *SARA*) also governs fish and fish habitat within the province of New Brunswick. SAR are species listed as Extirpated, Endangered, Threatened, or Special Concern by the NB *SARA*.

10.2.1.3 Other

Canadian Environmental Quality Guidelines (CEQG)

The Canadian Council of Ministers of the Environment (CCME) has established environmental quality guidelines for chemical-specific concentrations in various environmental media (CCME 2022). For the aquatic environment, the Canadian Environmental Quality Guidelines include the Canadian Water Quality Guidelines for the Protection of Aquatic Life (Freshwater) and the Canadian Sediment Quality Guidelines (CSQG) Probable Effects Level (PEL) and Interim Sediment Quality Guidelines (ISQG). As the CEQG environmental quality values are guidelines, they do not have force of law unless formally adopted by the provinces; however, they do provide a reasonable basis for establishing environmental quality.

10.2.2 Spatial Boundaries

The assessment of potential environmental interactions between the Project and the fish and fish habitat is focused on a Project development area (PDA) and a local assessment area (LAA).

The PDA for the Project is defined as the area of physical disturbance associated with the construction and operation and maintenance of the Project and is shown in Figure 2.1. As described in Chapter 2, for the purposes of this assessment, the PDA includes the upstream extents of the dam infrastructure, and downstream extents of the cofferdams to be installed during the construction phase.

The LAA for the aquatic environment is defined as the area within which the environmental effects of the Project can be measured or predicted. Considering a potential change in the aquatic environment, the LAA for the aquatic environment includes the Mactaquac headpond from approximately 10 km upstream of MQGS to approximately 20 km downstream to Fredericton (Figure 10.1). The LAA can be thought of as a theoretical “zone of influence” of the Project on the aquatic environment.

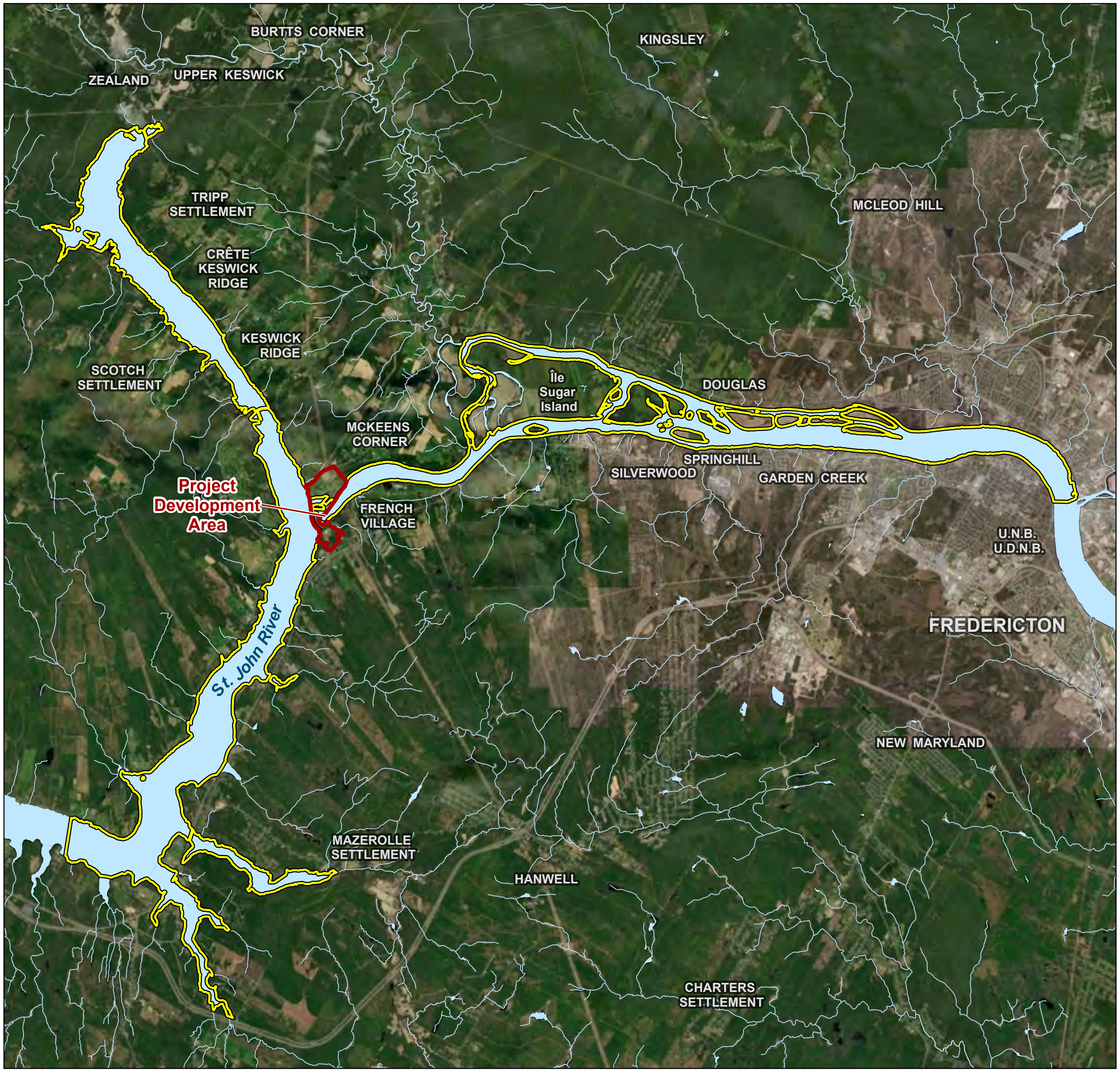


Figure No.
10.1

Title
Spatial Boundaries for Aquatic Environment

Client/Project 121415886_001

NB Power
Mactaquac Life Achievement Plan

Project Location Prepared by NW on 2022-09-01
Mactaquac Generating Station
York County, NB

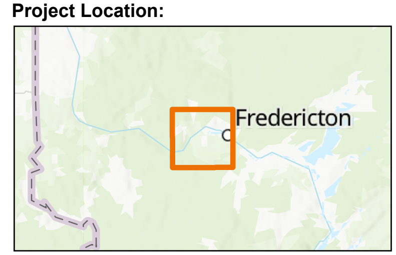
N

0 1 2 Kilometres
(At original document size of 8.5x11)
1:150,000

Legend

- Project Development Area
- Local Assessment Area
- Watercourse
- Waterbody

Project Location:



Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB, Service NB, NB DNR
3. Background: GeoNB, Service NB

Stantec

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10.2.3 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects on the aquatic environment include:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

10.3 EXISTING CONDITIONS FOR THE AQUATIC ENVIRONMENT

The description of fish and fish habitat below focuses on the current existing conditions within the St. John River upstream and downstream of MQGS and does not include a description of the conditions prior to the development of MQGS.

10.3.1 Approach and Methods

To characterize the existing conditions for the aquatic environment in support of the EIA registration, existing literature and information was reviewed. The review of existing literature and information included:

- Existing scientific literature on the St. John River and its fish populations, including but not limited to:
  - The Saint John River: A State of the Environment Report (CRI 2011)
  - Baseline Water Quality Conditions in the Saint John River (Dolson-Edge *et al*. 2018)
  - Baseline Biological Conditions in the Saint John River (Dolson-Edge *et al*. 2019a)
  - State of Fish Passage Design for the Mactaquac Generating Station (Samways *et al*. 2019)
  - Assessment of the Mactaquac Headpond Geomorphology and Estimated Sediment Distribution (O'Sullivan *et al*. 2016)
  - Preliminary Report on Mercury in Fish Upstream and Downstream of the Mactaquac Generating Station (Reinhart and Kidd 2018b)
  - COSEWIC status reports

The methods for establishing the existing conditions are detailed in the individual reports.

10.3.2 Description of Existing Conditions

10.3.2.1 Fish Habitat

Mactaquac Headpond

The section below provides a description of the existing fish habitat, including physical and chemical conditions within the Mactaquac headpond.

Physical Habitat

The Mactaquac headpond covers an 83 km^2 area and extends from the MQGS approximately 97 km upstream to just below Hartland (O'Sullivan *et al.* 2016). The headpond exhibits some lake-like characteristics such as thermal stratification and seasonal reductions in dissolved oxygen and velocity. The headpond has a maximum water depth of 50 m within the former river channel and an average depth of 8.0 m (Figure 10.2). The water elevation in the headpond is normally maintained between 39 and 40.5 m (128 and 133 ft) above mean sea level (amsl) during normal operating conditions associated with the management of the MQGS.

Substrate

Substrates in the littoral zone of the headpond consist of gravel, cobble, and fine substrates, whereas the deep, slow-flowing lentic waters of the headpond have predominantly silty surface sediments with some clay and sand (Yamazaki *et al*. 2016). The headpond consists of a relatively thin (5 cm to 30 cm) film of fine, unconsolidated sediments that are somewhat uniformly distributed from the town of Nackawic downstream to the MQGS (Yamazaki *et al.* 2016).

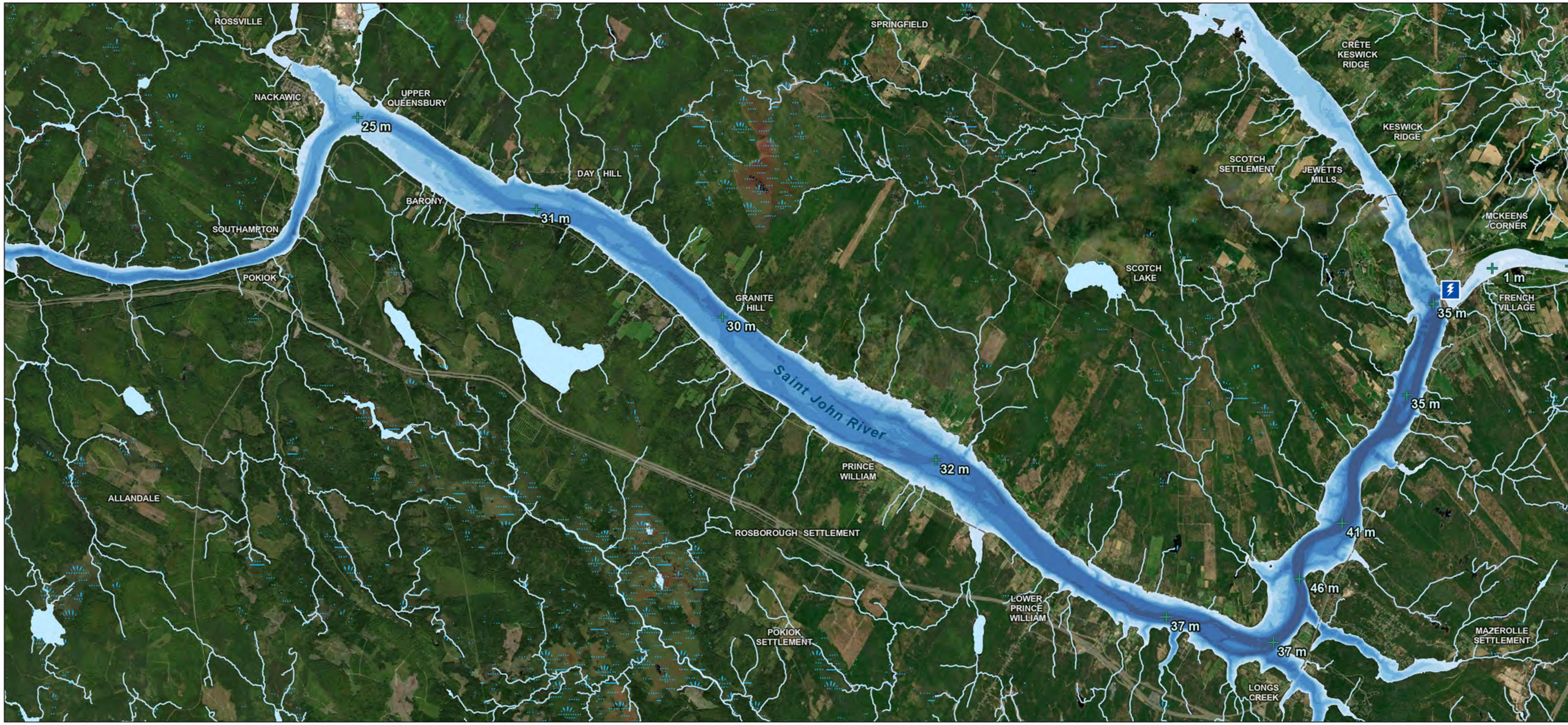
Inputs from industrial, agricultural, and municipal sources likely affect sediment quality in the St. John River (Culp *et al*. 2006). Trace metals (*e.g.*, total mercury), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and chlorinated pesticides have been found in sediments in the headpond (Reinhart and Kidd 2018a; Kidd *et al.* 2016); several trace metals (arsenic, chromium, nickel, and thallium), PAHs (acenaphthylene, benzanthracene, chrysene, fluoranthene, phenathrene, and pyrene), and chlorinated pesticides (DDE, DDD, and DDT) exceeded the CSQG ISQG (CCME 2022).

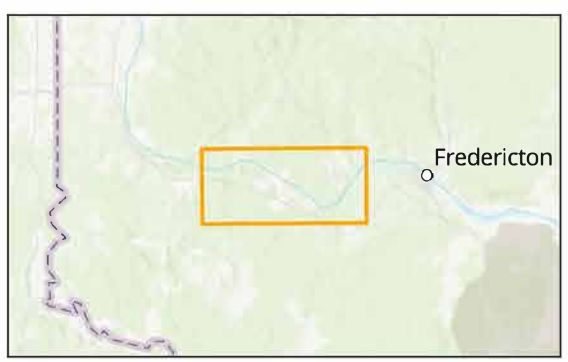
Primary Productivity

The littoral zone of the headpond includes shallow coves and inlets that support the growth of aquatic macrophytes, periphyton, and filamentous green algae (Cunjak and Newbury 2005; Culp *et al.* 2006). Aquatic macrophytes are typically limited to areas where water depths are less than 3 m. Numerous roots and stumps of trees that were cut prior to flooding of the headpond occur in the littoral zone. These habitats are often used by sunfish, perches, catfish, and minnows which feed on invertebrates such as larval insects and snails. These are then preyed upon by ambush predators like chain pickerel (*Esox niger*) and smallmouth bass (*Micropterus dolomieu*).

Plankton communities did not vary among stratified layers, suggesting that the thermal stratification is weak and does not prevent vertical mixing. The dominant genera in the phytoplankton community in the headpond are *Acanthoceras and Aulacoseira*, with smaller contributions from *Dinobryon*, *Asterionella, Ceratium,*, *Fragiliaria*, *Microcystis*, *Senedra,* and *Tabellaria* (Dolson-Edge *et al.* 2019a). *Microcystis,* often found in eutrophic lentic waters, can produce harmful algal blooms (Rinta-Kanto 2005). Total biovolume ranges from 1,115,000 to 971,091,000 μ^3 of plankton per mililitre (Dolson-Edge *et al.* 2019a). Zooplankton communities above MQGS were dominated by *Synchaeta*, *Polyarthra,* and *Keratella* and smaller proportions of *Trichnocerca*, *Bosmina*, and *Ploesoma* (Dolson-Edge *et al*. 2019a). Total biovolume ranges from 2,962 to 368,778 μ^3/ml (Dolson-Edge *et al.* 2019a).

Phytoplankton and zooplankton species richness in 2014 to 2016 in the St. John River was higher than was previously reported in the early 1970s (Watt 1973, Watt 1974, Watt & Duerden 1974). Observations included harmful cyanobacteria linked to algal blooms at sites where there had been significant blooming events in the past (Nguyen *et al*. 2019).





Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Canadian Rivers Institute (CRI), Stantec
3. Background: GeoNB, NB Department of Natural Resources and Energy Development (DNRED)

Bathymetry - Depth (m)
- 0
- 5
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45
- 50

Mactaquac Hydroelectric Generating Station

Sample Centre Depth (Derived from Bathymetric Contours)

Roads

Watercourse

Waterbody

0 2 4 Kilometres

(At original document size of 11x17)
1:100,000

N

Stantec

Project Location Prepared by NW on 2022-10-12

Mactaquac Generating Station
York County, NB

Client/Project 121415886_005

NB Power
Mactaquac Life Achievement Plan EA

Figure No.
10.2

Title
Bathymetry Within Mactaquac Headpond

Page 1 of 1

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Secondary Productivity

The littoral zone of the headpond supports a diverse community of aquatic organisms, many of which would not otherwise be abundant in this section of the St. John River as a result of the headpond. Littoral areas within the headpond likely support similar benthic communities to those upstream of the headpond and include abundances of *Ephemeroptera* (mayflies), *Tricoptera* (caddisflies) and *Diptera* (true flies) larvae (CRI 2022, unpublished data). Invertebrate communities in the deeper profundal zone are dominated largely by tubificid worms and chironomid midges (SJRBB 1974).

At least six of the 11 mussel species that occur in the St. John River are likely to occur in the headpond (Martel *et al*. 2010). Mussels occur along shallow shoreline areas and the upstream end of the headpond near Woodstock (Duerden *et al*. 1973; SJRBB 1974; Martel *et al*. 2010). Freshwater mussels, like the tidewater mucket (*Leptodea ochracea*) and alewife floater (*Anodonta implicata*) may be stranded during rapid summer drawdowns (Martel *et al.* 2010).

Flow

The highest flows in the St. John River occur in April and May, corresponding to the spring freshet. Flow is slightly higher in the fall (October to December) compared with dry months of January, February, July, and August. The average annual flow upstream of MQGS at Florenceville (01AJ001) is 663 m^3/s (ranging from 13 to 9,170 m^3/s).

The frequency and magnitude of large floods in the St. John River has increased since 1968, due to changes in climate in the St. John River watershed (CRI 2011). Ice jams are the most dramatic of flood events and are caused by the breakup and rapid accumulation of fragmented river ice (Environment Canada 2011).

Water Quality

Water quality parameters influence the quality of fish habitat for species residing in the Mactaquac headpond.

The temperature of water in the headpond varies among seasons, years, and locations, as well as between the surface and the deeper bottom waters (SJRBB 1975; FAC 1994; FAC 1995; Bradford, R., pers. comm., 2014; Dolson-Edge *et al* 2019a, 2019b; Lento *et al*. 2022 in preparation). The headpond typically exhibits thermal stratification between July and September and is typically strongest at deeper sites (Lento *et al*. 2022 in preparation). Summer surface water temperatures can reach as high as 25.4°C in July or August (Dolson-Edge *et al.* 2019a; Lento *et al.* 2022 in preparation) whereas summer bottom waters can be 10 to 15°C cooler than the overlying surface waters as a result of the thermocline (SJRBB 1975; FAC 1994; FAC 1995; Lento *et al.* 2022 in preparation). The depth of the thermocline typically occurs around 15 m in August, though its depth varies by season and location (Lento *et al*. 2022 in preparation).

Most of the recorded dissolved oxygen (DO) levels fall within the acceptable range (CCME 2022; CRI 2011; Lento *et al*. 2022 in preparation). DO levels have been shown to decline markedly near the bottom of the deeper areas of the headpond, reaching values as low as 1.0 mg/L in summer (FAC 1995) and 2.5 mg/L in winter (SJRBB 1975). Dissolved oxygen depth profiles revealed that conditions in the headpond frequently fell below the threshold for aquatic life (6.5 mg/L DO; CCME 2022) in August and September (Dolson-Edge *et al*. 2019b) and to levels that would be considered hypoxic (<5.5 mg/L) or anoxic (<1 mg/L; Lento *et al*. 2022 in preparation). Overall, the decline in oxygen at depth is indicative of medium to high biological productivity (Dolson-Edge *et al*. 2019a). These conditions may expose cold-water species (such as salmonids) to stressful conditions during their summer migration through the headpond (Dolson-Edge *et al.* 2019a).

NBDELG (2015) has reported a few pH values below CCME guidelines upstream of the MQGS; however, these isolated dips in pH likely relate to daily and seasonal fluctuations. Between 2003 and 2022, values of pH upstream of MQGS ranged from 5.9 to 8.8 (mean = 7.7; NB Waters 2022) which are consistent with previous studies (FAC 1994; CRI 2011).

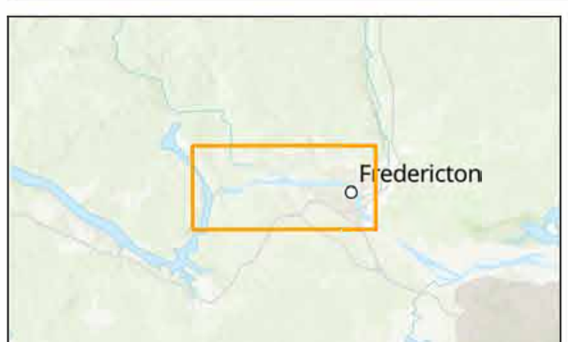
Turbidity values typically range from 7 to 22.0 nephelometric turbidity units (NTU; Wallace and Gautreau 2015) and are typically low and suitable for supporting aquatic life (CRI 2011). Higher turbidity levels have been recorded upstream of the MQGS (up to 441 NTU; NB Waters 2022; NBDELG 2022) but are generally short-term and associated with high-water events.

St. John River Downstream of MQGS

The habitats downstream of the MQGS are typical of a large, regulated river environment characterized by higher velocities (particularly in the area upstream of Fredericton) and lower water depths than those in much of the headpond. The shallower depths enable greater mixing, reduced thermal stratification, and more consistent DO concentrations and water temperatures. A more detailed description of habitats is described below.

Physical Habitat

The downstream environment below the MQGS is riverine, with shallow (typically less than 5 m) and fast-flowing waters that are influenced by water releases during periods of high electrical demand and/or high flow conditions. The MQGS causes daily downstream water level fluctuations of up to 1 m that are mainly limited to short-term changes within the first 30 km to 40 km below the MQGS (Luiker *et al*. 2013). The downstream riverbanks have a shallow slope; therefore, water depth gradually increases with distance from the shore (Figure 10.3).



Bathymetry - Depth (m)

- 0
- 5
- 10
- 15
- 20
- 25
- 30
- 35
- 40

Mactaquac Hydroelectric Generating Station

Sample Centre Depth (Derived from Bathymetric Contours)

Roads

Watercourse

Waterbody

0 1 2 Kilometres

(At original document size of 11x17)
1:60,000

N

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Canadian Rivers Institute (CRI), Stantec
3. Background: GeoNB, NB Department of Natural Resources and Energy Development (DNRED)

Stantec

Project Location Prepared by NW on 2022-10-12
Mactaquac Generating Station
York County, NB

Client/Project 121415886_006

NB Power
Mactaquac Life Achievement Plan EA

Figure No.
10.3

Title
Bathymetry In the St. John River Downstream of MQGS

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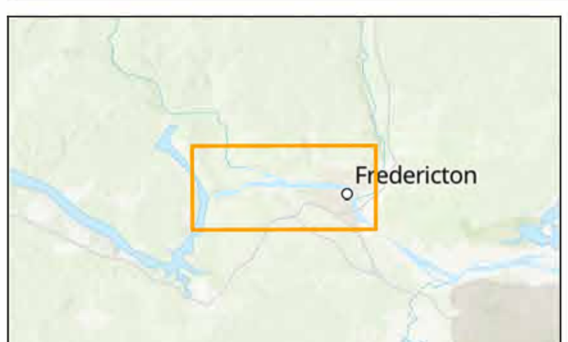
Substrate

Riverine environments, such as those downstream of the MQGS, are characterized by substrates dominated by pebble, sand, and organics. (Figure 10.4). Substrates closer to the dam are a mixture of coarse and fine particle sediments while downstream substrates became more homogenous and sandier (MacLean *et al*. 2016). The tailrace, located directly downstream of the MQGS is characterized by fast flow and coarse substrate, and is most affected by daily water level fluctuations, whereas the side channel to the north (influenced by the Keswick River) has slower flow, higher turbidity, and finer sediments. To the east, several islands within the St. John River present a significant amount of heterogeneous habitat with gravel bars, downstream of which the main channel becomes wider and deeper with finer substrates (Wegscheider *et al*. 2018). In general, suspended fine sediments have a short residence time in the St. John River as moderate to high velocity flow events facilitate transport downstream.



Substrate Type

- CLAY
- COARSE ORGANIC
- FINE ORGANIC
- GRAVEL
- PEBBLE
- SAND
- SMALL COBBLE
- SMALL PEBBLE

- Mactaquac Hydroelectric Generating Station
- Watercourse
- Waterbody
- Wetlands_2021

0 1 2 Kilometres
(At original document size of 11x17)
1:60,000

N

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Canadian Rivers Institute (CRI), Stantec
3. Background: GeoNB, NB Department of Natural Resources and Energy Development (DNRED)

Stantec

Project Location Prepared by NW on 2022-10-12
Mactaquac Generating Station
York County, NB

Client/Project 121415886_006

NB Power
Mactaquac Life Achievement Plan EA

Figure No.
10.4

Title
Sediment Composition In the St. John River Downstream of MQGS

Page 1 of 1

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Primary Production

The frequent wetting and drying of river margins in areas immediately downstream of the MQGS creates shoreline conditions that can be unfavourable for some plants (*e.g.,* algae and macrophytes). Aquatic macrophytes, such as watermilfoil (*Myriophyllum sp.),* pondweed *(Potamogeton spp.),* and eelgrass *(Vallisneria)*, are common in the shallow, calm waters downstream of the MQGS (Hinds 2000).

Hydro-acoustic surveys reveal that approximately 24% of the 13.8 km^2 of surveyed riverbed between the MQGS and Fredericton are covered in submerged aquatic macrophytes, mostly in areas of lesser flow (*i.e*., in sheltered coves amongst islands and in the margins of the main channel; Dolson-Edge *et al*. 2019a). A total of 29 macrophyte species were observed across 171 survey sites, including several species listed as potentially vulnerable, imperiled, or introduced under the New Brunswick Provincial conservation ratings, and the identification of one previously unreported invasive species, the Eurasian watermillfoil (*Myriophyllum spicatum)*.

The downstream phytoplankton communities are dominated by *Aulacoseira* (51.5%), *Asterionella* (12.2%), *Fragiliaria* (5.0%), *Ulothrix* (10.2%), and *Oedogonium* (3.4%). O*edogonium*, though found below the MQGS, is typically found in lentic environments (David 2003). Zooplankton communities below MQGS were dominated by *Synchaeta* (66.3%), *Polyarthra* (16.7%), and *Keratella* (9.1%) which are similar communities to those found upstream of MQGS.

Secondary Productivity

There exists a large amount of inter-annual variation in benthic invertebrate community (BIC) diversity in the St. John River downstream of the MQGS, however, little annual variation (Dolson-Edge *et al*. 2019a). There were typically a higher proportion of Chironomids to Ephemeroptera, Plectotera, and Tricoptera (EPT) taxa (Dolson-Edge *et al*. 2019a). BIC, Simpson’s diversity index, or the EPT index did not demonstrate the same temporal trends at sites across years, nor did mean annual index values pooled across non-reference sites differ. The Hilsenhoff Family Index[1] (HFI) suggested that areas downstream of the MQGS had poorer ecosystem health; however, these conclusions are also highly dependent on prolonged low flow events (Dolson-Edge *et al*. 2019a). While there are no previously reported HFI values downstream of the MQGS (Cunjak *et al*. 2011), upstream areas of the watershed have been found to range from good to excellent HFI values.

Dragonfly exuviae (*i.e.,* the empty cast from which odonates emerge into adulthood) were collected during peak emergence during the months of June and July in the summers of 2014 to 2016 along the banks of the St. John River downstream of the MQGS in wetland, tributary, and large river habitats. Thirty-two species were identified over three years, including the skillet clubtail (*Gomphus ventricosis*). The number of species identified from exuviae remained relatively constant between years, though the species composition varied (Dolson-Edge *et al.* 2019a). Mean annual Simpson’s diversity index[2] did not reveal any trends among years within sites or between tributary, large river habitats, or wetland habitats.

[1] The HFI provides a quantitative measure of the tolerance of aquatic invertebrates to organic water quality pollution
[2] Simpson’s diversity index is a measure of the distribution of individuals among sampled taxa

A 2016 snorkeling survey observed 5 of 11 freshwater mussel species documented in the St. John River at 28 sites downstream from the MQGS to the Oromocto-Gagetown area (Maclean *et al*. 2016). Neither of the SAR (*i.e.*, yellow lamp mussel [*Lampsilis cariosa*] and brook floater [*Alasmidonta varicosa*]), were observed. Mussel abundance and diversity increased downstream from MQGS and peaked near Fredericton. Freshwater mussels in the St. John River were most commonly found in sandy substrate with high embeddedness.

Flow

The highest flows in the St. John River downstream of MQGS occur in April and May, corresponding to the spring freshet. Flow is slightly higher in the fall (October to December) compared to dry months of January, February, July, and August. The average annual flow downstream of MQGS (01AK004) is 813 m^3/s (ranging from 813 to 11,100 fm^3/s).

Water Quality

Water temperatures downstream of the MQGS vary with season and year, but substantially less so than in the headpond due to the lack of thermal stratification. Summer temperatures reach as high as approximately 25°C in August (Lento *et al*. 2022 in preparation). Hydrological temperature modelling suggests that the Mactaquac headpond may buffer daily and seasonal downstream temperature changes, though this may vary depending on the depth from which water is drawn from in the headpond and the time of year (Dugdale *et al*. 2016).

DO levels measured downstream of the MQGS are generally not a limiting factor to native aquatic organisms as they are typically above the threshold for aquatic life (>6.5 mg/L DO; CCME 2022) (CCME 2022; Lento *et al*. 2022 in preparation). More vertically stable DO levels are found downstream of the MQGS, which is likely due to the mixing of the water column that occurs in faster flowing sections of the river (Nguyen *et al*. 2017).

Between 2003 and 2022, values of pH downstream of MQGS ranged from 6.7 to 8.6 with a mean of 7.5 (NB Waters 2022), which are consistent with previous studies (Dolson-Edge *et al*. 2018; CRI 2011). As such, the pH of water downstream of the MQGS appears to be well within a suitable range (6.5 to 9) to support aquatic life (CCME 2022; CRI 2011).

Turbidity values typically range from 0.4 to 52.8 NTU and are typically low with an average of 3.4 NTU. (NBDELG 2022). Similar to upstream, higher turbidity values are typically associated with high-water events.

10.3.2.2 Fish Species

This section presents an overview of fish species that are present in the St. John River system and those that may be present in the LAA. The habitats within the St. John River near MQGS support both cold- and warm-water fish communities (Wegscheider *et al*. 2018). A total of 55 fish species have been identified within the entire St. John River watershed (CRI 2011; Gautreau and Curry 2020), and of those, 49 are known to be present upstream or downstream of MQGS. 46 are known to be present downstream of

MQGS to the confluence of the Bay of Fundy, and 41 species are presently known to occur between Beechwood and MQGS (Table 10.1).

In the St. John River downstream of MQGS, gaspereau (*Alosa sp.*), common shiner (*Luxilus cornutus*), banded killifish (*Fundulus diaphanous*), yellow perch (*Perca flavescens)*, white sucker (*Catostomus commersoni)*, brown bullhead (*Ictalurus nebulosus)*, smallmouth bass (*Micropterus dolomieu*), American eel (*Anguilla rostrata*), and fourspine stickleback (*Apeltes quadracus*) are commonly captured (Dolson-Edge *et al*. 2019a). There are 11 fish species that are diadromous and require both freshwater and marine environments to carry out their life cycles (Table 10.1). Figure 10.5 shows the migratory timing for diadromous fishes in near MQGS. Most upstream movements for most species occur in the spring and early summer, whereas downstream migration tends to occur in the fall. Six invasive fish species are present downstream of MQGS (Table 10.1). Smallmouth bass and muskellunge are popular species for recreational anglers within the St. John River.

Within the Mactaquac headpond, gaspereau, brown bullhead, yellow perch, pumpkinseed sunfish (*Lepomis gibbosus)*, and white sucker are the common fish species (Gautreau *et al*. 2018; CRI 2011; Curry and Gautreau 2010). American shad (*Alosa sapidissima*), Atlantic sturgeon (*Acipenser oxyrinchus*), lake whitefish (*Coregonus clupeaformis*), redbreast sunfish (*Lepomis auritus*), sea lamprey (*Petromyzon marinus*), shortnose sturgeon (*Acipenser brevirostrum*), and striped bass (*Morone saxatilis*) were likely historically present above MQGS but are no longer present upstream (CRI 2011). As there is no current fish passage for these species over the MQGS, the species listed above are not considered to be present or incidental upstream of the PDA. Six invasive fish species are present upstream of MQGS within the reach between Beechwood and MQGS (Table 10.1).

Commercial, recreational, and Indigenous fisheries are known to occur in the LAA and other areas of the St. John River.

Gaspereau support an important commercial fishery in the lower St. John River in spring and early summer (Jessop 2001b). A commercial harvest for gaspereau exists at the MQGS, within the PDA (Jessop 2001a).

Fish such as smallmouth bass (*Micropterus dolomieui)*, landlocked salmon (*Salmo salar sp.*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Salmo gairdneri*), smelt (*Osmerus mordax*), whitefish (*Coregonus sp.*), chain pickerel (*Esox niger*), muskellunge (*Esox masquinongy*), burbot (*Lota lota*), yellow perch (*Perca flavescens*), and white perch (*Morone americana*) are recreationally fished in the lower Saint John Recreational Fishery Area, including the Mactaquac headpond and downstream of MQGS to its confluence of the Bay of Fundy.

Indigenous fishing for food, social, and ceremonial purposes may occur within the St. John River and its tributaries for alewife, American eel, American shad, sea lamprey, brown bullhead, yellow and white perch, chain pickerel, sunfish, muskellunge, smallmouth bass, striped bass, sturgeon, white and longnose sucker, burbot, whitefish, chub, smelt, and brook trout (Stantec 2016).

Table 10.1 Fish Species Presence Upstream and Downstream of the MQGS in the St. John River Basin

Species	Upstream	Downstream	Species	Upstream	Downstream
Alewife (*Alosa pseudoharengus*) (D)	X	X	Golden shiner (*Notemigonus crysoleucas*)	X	X
American eel (*Anguilla rostrata*) (D)	X	X	Lake chub (*Couesius plumbeus*)	X	X
American shad (*Alosa sapidissima*) (D)	X	X	Lake whitefish (*Coregonus clupeaformis*)	X	X
Atlantic sturgeon (Acipenser oxyrhynchus) (D)	O	X	Largemouth bass (Micropterus salmoides) (I)	X	-
Atlantic salmon (*Salmo salar*) (D; landlocked)	X	X	Longnose sucker (*Catostomus Catostomus*)	X	X
Atlantic tomcod (*Microgadus tomcod*) (D)	-	X	Mummichog (*Fundulus heteroclitus*)	-	X
Banded killifish (*Fundulus diaphanus*)	X	X	Muskellunge (*Esox masquinongy*) (I)	X	X
Black crappie (*Pomoxis nigromaculatus*) (I)	X	-	Ninespine stickleback (*Pungitius pungitius*)	X	X
Blacknose dace (*Rhinichthys atratulus*)	X	X	Northern redbelly dace (*Chrosomus eos*)	X	X
Blacknose shiner (*Notropis heterolepis*)	X	X	Pearl dace (*Semotilus margarita*)	X	X
Blackspotted stickleback (*Gasterosteus wheatlandi*)	X	X	Pumpkinseed (*Lepomis gibbosus*)	X	X
Blueback herring (*Alosa aestivalis*) (D)	X	X	Rainbow smelt (*Osmerus mordax*) (D)	X	X
Brook stickleback (*Culaea inconstans*)	-	X	Rainbow trout (*Salmo gairdneri*) (I)	X	X
Brook trout (*Salvelinus fontinalis*)	X	X	Redbreast sunfish (*Lepomis auritus*)	O	X
Brown bullhead (*Ictalurus nebulosus*)	X	X	Round whitefish (*Prosopium cylindraceum*)	X	-

Table 10.1 Fish Species Presence Upstream and Downstream of the MQGS in the St. John River Basin

Species	Upstream	Downstream	Species	Upstream	Downstream
Brown trout (*Salmo trutta*) (I)	X	X	Sea lamprey (*Petromyzon marinus*) (D)	X	X
Burbot (*Lota lota*)	X	X	Shortnose sturgeon (Acipenser brevirostrum) (D)	O	X
Central mudminnow (*Umbra limi*) (I)	-	X	Slimy sculpin (*Cottus cognatus*)	X	X
Chain pickerel (*Esox niger*) (I)	X	X	Smallmouth bass (*Micropterus dolomieui*) (I)	X	X
Common shiner (*Notropis cornutus*)	X	X	Striped bass (*Morone saxatilis*) (D)	O	X
Creek chub (*Semotilus atromaculatus*)	X	X	Threespine stickleback (*Gasterosteus aculeatus*)	X	X
Fallfish (*Semotilus corporalis*)	X	X	White perch (*Morone americana*)	X	X
Fathead minnow (*Pimephales promelas*)	X	X	White sucker (*Catostomus commersoni*)	X	X
Finescale dace (*Chrosomus neogaeus*)	X	X	Yellow perch (*Perca flavescens*)	X	X
Fourspine stickleback (*Apeltes quadracus*)	X	X			

Notes:
O – Historic records (Meth 1973)
X – Present Record (CRI 2011; Gautreau and Curry 2020)
D – Diadromous
I – Invasive/Non-native
No record of occurrence

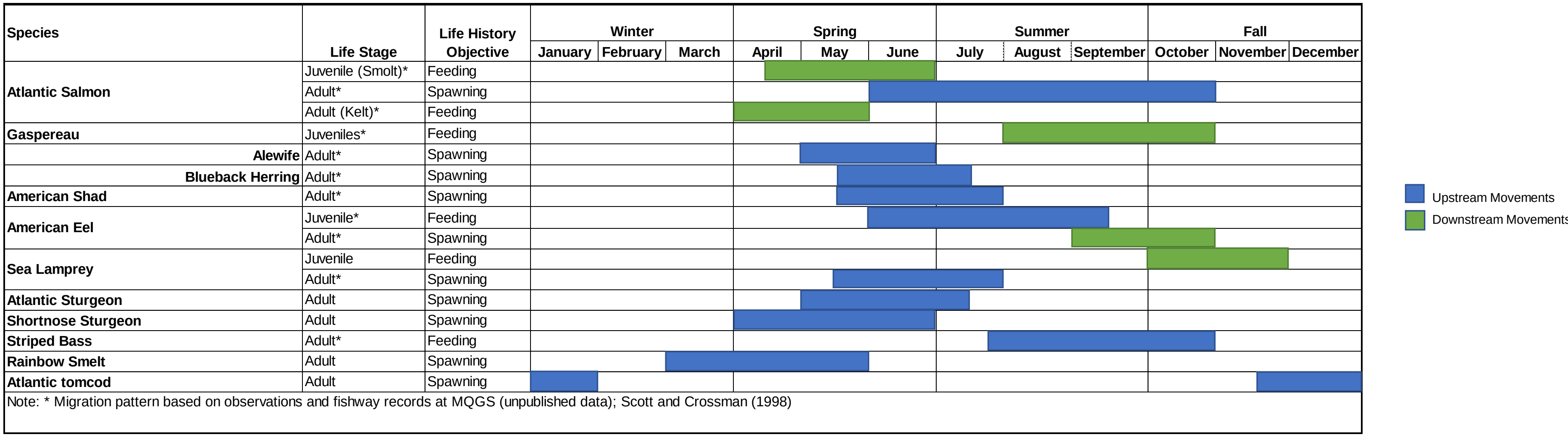

Figure 10.5 Migratory Timing of Diadromous Fish Species Within the LAA

10.3.2.3 Species at Risk

For the purposes of this EIA registration, SAR include those listed as Extirpated, Endangered, Threatened, or Special Concern by the federal *SARA*, NB *SARA*, or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC assesses and designates the status of species and recommends this designation for legal protection under *SARA*. For aquatic SAR, only species listed as Extirpated, Endangered, or Threatened on Schedule 1 and their habitats are protected by the prohibitions of *SARA*.

Species of Conservation Concern (SOCC) are those species that do not meet the above definition of SAR, but are considered rare in New Brunswick, or the long-term sustainability of their populations has been evaluated as tenuous. SOCC are defined here as non-SAR species ranked S1 (Critically Imperiled), S2 (Imperiled), or S3 (Vulnerable) in New Brunswick by the Atlantic Canada Conservation Data Centre (AC CDC) (AC CDC 2022) with the potential to occur in the LAA. SOCC are included in this VC as a precautionary measure, reflecting observations and trends in their provincial population status, and are often important indicators of ecosystem health and regional biodiversity.

While some species included as SAR in this assessment currently have regulatory protection as they are listed under Schedule 1 of the federal *SARA* or the *Prohibitions Regulation* of NB *SARA*, the definition above also includes those species on the NB *SARA List of Species at Risk Regulation* and those listed by COSEWIC that are candidates for further review and may become protected (covered by prohibitions) within the timeframe of this Project.

Ten aquatic SAR/SOCC may be present or have the potential to be present within the LAA.

Table 10.2 provides an update of each species' local distribution, life history traits, threats and limiting factors, current conservation status, and their known occurrence in the LAA.

Table 10.2 Aquatic Species at Risk and/or Species of Conservation Concern That May Occur in the LAA

Species	Local Distribution, Key Life History Traits, and Anthropogenic Interactions	Conservation Status			
		SARA[1]	COSEWIC[1]	NB *SARA*[2]	SRank[3]
Fishes					
American eel (*Anguilla rostrata*)	A long-lived, bottom-dwelling predator, it spends most of its life in freshwater and estuarine environments, and then migrates to sea to spawn and die. Spawning migration occurs in the fall; larvae arrive in estuaries in spring and early summer (Groom 1975; COSEWIC 2012a). Once common throughout the St. John River, eel abundance upstream of the MQGS has decreased significantly since the construction of the dam while populations downstream have remained stable (Gautreau *et al*. 2018). Existing population pressures include habitat degradation and barriers to migration (Chaput *et al.* 2014).	No status (under consideration)	Threatened (2012)	Threatened	SN4 (Apparently secure nonbreeding)
Atlantic salmon[3] (*Salmo salar*)	An anadromous species that spawns and rears in clean, gravel-bottomed freshwater environments. In the spring of the year smolts migrate to the sea to feed and mature for 1–2 years before returning back to their natal streams and rivers (COSEWIC 2010a; DFO 2014). Atlantic salmon of the St. John River are of the Outer Bay of Fundy (OBoF) population. This population has nearly collapsed; recent returns to the St. John River are a fraction of historical stocks (DFO 2014). Densities of salmon fry and parr above and below MQGS remain low (DFO 2020). OBoF populations are threatened by reduced marine survival (COSEWIC 2010a), dams and other migration obstructions (Fay *et al.* 2006; Clarke *et al.* 2014).	No status (under consideration)	Endangered (2010)	Endangered	SNR (Unranked)
Atlantic sturgeon[4] (*Acipenser oxyrinchus*)	A large, long-lived, bottom-dwelling anadromous species, it spends much of its life in the sea. They enter rivers as early as May and spawn over rocky/gravel substrates in the St. John River between July and August (Bradford *et al*. 2016; COSEWIC 2011). Juveniles remain in fresh water for the first summer before migrating to estuaries for the winter (COSEWIC 2011). The Maritime population spawns only in the lower St. John River area, downstream of the MQGS (COSEWIC 2011; CRI 2011). The species may have inhabited areas further upstream prior to construction of MQGS (DFO 2009a).	No status (under consideration)	Threatened (2011)	Threatened	SNR (Unranked)

Table 10.2 Aquatic Species at Risk and/or Species of Conservation Concern That May Occur in the LAA

Species	Local Distribution, Key Life History Traits, and Anthropogenic Interactions	Conservation Status			
		SARA[1]	COSEWIC[1]	NB *SARA*[2]	SRank[3]
Redbreast sunfish (*Lepomis auritus*)	A small inhabitant of warm water lakes and slow-moving rivers with rocky or well-vegetated habitat, it spawns in the spring (COSEWIC 2008a). New Brunswick is the northern extent of its range. Found in low abundance in the lower St. John River drainage, it has recently been reported in the Oromocto River, the Canaan River, and Longs Creek (CRI 2011; Stantec 2014). There is no recent evidence that its distribution reaches the MQGS. However, it may have been present in upstream reaches before MQGS was constructed (Meth 1973).	Special Concern, Schedule 3	Data deficient (2008)	No status	S4 (Apparently Secure)
Shortnose sturgeon (*Acipenser brevirostrum*)	A large, long-lived, bottom-dwelling anadromous fish, in Canada, it is known to occur only in the lower St. John River drainage. It occupies very similar freshwater habitats to those of Atlantic sturgeon. It spawns in the spring within 17 km downstream of MQGS (Usvyatsov *et al.* 2013; COSEWIC 2005). The larva drift and develop downstream. There are known overwintering areas in the Kennebecasis River. Its downstream migration is believed to be limited to the estuary. Construction of MQGS may limit habitat for the local population to areas downstream.	Special Concern, Schedule 1	Special Concern (2015)	Special Concern	S3 (Vulnerable)
Striped bass[5] (*Morone saxatilis*)	A large, anadromous predator (COSEWIC 2012b), it occurs within the St. John River system, generally downstream of the MQGS. There is genetic evidence of a spawning population and capture of gravid individuals, but recruitment is uncertain (COSEWIC 2012b; Andrews *et al*. 2017). There has been no evidence of successful reproduction in the St. John River for several decades (COSEWIC 2012b; Andrews *et al.* 2017). Current inhabitants may be foraging migrants from the United States or Nova Scotia populations (Andrews *et al.* 2017). This species is present in the fish lift and immediately downstream of MQGS (Andrews *et al.* 2017). Historically, it spawned in areas upstream of the MQGS (CRI 2011). Striped bass habitat was likely affected by the construction of MQGS (Jessop 1995; Andrews *et al.* 2017).	No status (under consideration)	Endangered (2012)	Endangered	S2N, SHB (Imperiled nonbreeding, possibly extirpated breeding)

Table 10.2 Aquatic Species at Risk and/or Species of Conservation Concern That May Occur in the LAA

Species	Local Distribution, Key Life History Traits, and Anthropogenic Interactions	Conservation Status			
		***SARA*[1]**	**COSEWIC[1]**	**NB *SARA*[2]**	**SRank[3]**
Mussels					
Brook floater (*Alasmidonata varicosa)*	A medium-sized freshwater mussel found in small streams over sandy substrates (COSEWIC 2009a), its larvae are parasites on the gills or fins of various fishes; therefore, it can disperse over considerable distances. Only one historical record exists within the St. John River system (Aroostook River; COSEWIC 2009a), but the species could reside in other areas of the watershed. Not confirmed present within the LAA (Maclean *et al*. 2016). The primary existing population pressures include anthropogenic activities that lead to siltation.	Special Concern, Schedule 1	Special Concern (2009)	Special Concern	S3 (Vulnerable)
Yellow lampmussel (*Lampsilis cariosa*)	A relatively large freshwater mussel that prefers slow-moving water and sand/small gravel substrates, it is common in the lower St. John River system downstream of Mactaquac (COSEWIC 2004). It may currently be, or have historically been, present upstream of the MQGS (Sabine *et al.* 2004; DFO 2009b). Potential to occur within the LAA (COSEWIC 2004). Local population is relatively stable. Existing population pressures include habitat degradation related to siltation and other pollutants. Distribution may be limited by the abundance and distribution of host species (*e.g.*, perches) for larvae.	Special Concern, Schedule 1	Special Concern (2013)	Special Concern	S3 (Vulnerable)
Insects					
Pygmy snaketail (*Ophiogomphus howei*)	Larval dragonflies are benthic predators that develop among sand/small gravel substrates in fast-flowing sections of large (>10 m wide) rivers. Adults are terrestrial. It has been found in three locations along the upper St. John River (COSEWIC 2018) but could be widespread throughout the watershed (Catling 2002; COSEWIC 2008b; Brunelle, P.M., pers. comm., 2015). Not found within the LAA (O'Malley 2014; Dolson-Edge *et al.* 2019a). Breeding is generally unsuccessful directly upstream and downstream of dams (Environment Canada 2013). Potential population pressures include dam construction and invasive aquatic species (COSEWIC 2008b; 2018).	Special Concern, Schedule 1	Special Concern (2018)	Special Concern	S2S3 (Imperiled to vulnerable)

Table 10.2 Aquatic Species at Risk and/or Species of Conservation Concern That May Occur in the LAA

Species	Local Distribution, Key Life History Traits, and Anthropogenic Interactions	Conservation Status			
		SARA[1]	COSEWIC[1]	NB *SARA*[2]	SRank[3]
Skillet clubtail (*Gomphus ventricosus*)	A dragonfly species that occurs frequently in the lower St. John River, between Fredericton and Washademoak Lake (COSEWIC 2010b). Occurs in large, slow-flowing rivers and lakes with sand and mud substrates. Its larvae are benthic predators that are somewhat sensitive to siltation but commonly occur in relatively turbid waters. Construction of the MQGS may have destroyed considerable upstream habitat for this species, but it does not appear to disrupt breeding in downstream areas. Not found within the LAA (O'Malley 2018; Dolson-Edge *et al*. 2019a).	Endangered, Schedule 1 (2017)	Endangered (2010)	Endangered	S2 (Imperiled)

Notes:
1. Source: Government of Canada 2021.
2. Source: http://www2.gnb.ca/content/gnb/en/departments/natural_resources/wildlife/content/SpeciesAtRisk.html.
3. Outer Bay of Fundy population.
4. Maritimes population.
5. Bay of Fundy population.

10.3.2.4 Fish Passage

Based on the historical data and supplemented with knowledge obtained during studies in support of the Mactaquac Life Achievement Project (MLAP), Canadian Rivers Institute (CRI), in discussion with Wolastoqey Nation in New Brunswick (WNNB) and Fisheries and Oceans Canada (DFO), has identified that six fish species presently require passage for critical lifecycle purposes (Samways *et al.* 2019). The six species requiring passage at MQGS to carry out their life processes are: Atlantic salmon, alewife, blueback herring, American eel, American shad, and sea lamprey.

Fish passage at MQGS (described in detail in Chateauvert, *et al*., 2018) has been undertaken with an active trap-and-truck system in the upstream migratory direction, with downstream passage being passive and limited to passage through the turbines or through the spillways, since its initiation. The current operational fish passage protocol is limited to the passage of Atlantic salmon and gaspereau (*i.e,* alewife, and blueback herring), though the existing fish collection facility is technically and demonstrably capable of providing passage for other species at varying efficiencies. The fish passage collection facility (*i.e.*, fish lift) is located on the downstream side of the powerhouse, adjacent to the turbine water outflow of Units 1 and 2 (Ingram 1980). DFO uses this facility in support of its management objectives. Trapped salmon are taken first by truck to the Mactaquac Biodiversity Facility for secondary sorting and are then transported upstream of MQGS by truck and released, either upstream of the Mactaquac Headpond or upstream of the other existing dam structures (*i.e.*, Beechwood and Tobique dams) within the St. John River. The amount of gaspereau transported upstream has varied throughout the life of the MQGS. Since 1995, the formal objective has been to pass 200,000 blueback herring and 800,000 alewife, though the total number of gaspereau passed has often greatly exceeded this amount, and in recent years the practice is to pass all gaspereau captured within the trap. Gaspereau are transported and released directly to the headpond just a short distance upstream of MQGS. The Mactaquac Biodiversity Facility also operates a trap downstream of the powerhouse; however, most fishes are captured at MQGS (Ingram 1980; Anderson, L., pers. comm., 2015). The trap-and-truck passage system is operated each year during key migration periods, typically from early-May to the end of November, except when conditions prohibit operation (*e.g.,* periods of high flow, later than normal spring freshet). At present, the operation of the fish collection facility is limited to weekdays and during daylight conditions.

MQGS does not have infrastructure designed specifically for fish passage that aids the downstream movement of fishes from the headpond past the dam. Fishes must move through the turbines, through the spillway or through the diversion sluiceway; however, the spillway and diversion sluiceway can be accessed only during periods of high-water flow when spilling occurs, such as during the spring.

Recent studies on fish passage by Mactaquac Aquatic Ecosystem Study (MAES) have focused on assessing the ability of species to move upstream and downstream of the MQGS. For Atlantic salmon, navigating the headpond can be a challenge for both adults moving upstream to spawning grounds and juveniles/adults moving downstream to the sea. Juvenile and adult salmon can be delayed, or are unable, to navigate the headpond (Linnansaari, T., pers. comm., 2016; Babin *et al.* 2016). Gaspereau populations have increased since the construction of MQGS, reflecting the suitability of lake-like conditions of the headpond for these species for spawning and rearing (O'Gorman and Stewart 1999; Jessop 2001a). American eel elvers have been found to move between spillway gates and make multiple ascents at the

MQGS during their asynchronous migration (Dixon *et al.* 2018). They are not likely limited by a velocity barrier potentially created by MQGS and are able to migrate upstream under suitable conditions.

10.3.2.5 Mercury in Fish Tissue

The tissues of 11 species of fish of varying sizes were sampled in 2017 upstream and downstream of MQGS and analyzed for mercury (Table 10.3; Reinhart and Kidd 2018b). The number of each species varied and not all species were sampled both upstream and downstream. Of the six species sampled upstream of MQGS only one species, smallmouth bass, had concentrations of mercury that exceeded the Health Canada guideline of 0.5 mg/kg (Table 10.3). Of the seven species sampled downstream of MQGS, three species, including muskellunge, shortnose sturgeon, and striped bass, were found to have levels of mercury that exceeded Health Canada guideline of 0.5 mg/kg (Table 10.3). These species are either predatory (*i.e.*, muskellunge, striped bass, and smallmouth bass) or long-lived (*i.e.*, shortnose sturgeon); therefore, mercury is more likely to be present because of bioaccumulation and/or biomagnification.

Table 10.3 Total Mercury Concentrations in Fish Tissues from Fish from the St. John River (Compiled from Reinhart and Kidd 2018b)

Species	UPSTREAM OF MQGS		DOWNSTREAM OF MQGS	
	Mean Concentration (mg/kg ww) ± SD*	Sample Size	Mean Concentration (mg/kg ww) ± SD*	Sample Size
American eel (*Anguilla rostrata*)	0.49	1	0.24 ± 0.07	20
Gaspereau (*Alosa pseudoharengus and A. aestivalis*)	0.1 ± 0.03	5	0.07 ± 0.01	8
Smallmouth bass (*Micropterus dolomieu*)	**0.56 ±0.29**	12	0.38 ± 0.42	20
Largemouth bass (*Micropterus salmoides*)	0.12 ± 0.21	24	-	0
White perch (*Morone americana*)	0.15	1	-	0
White sucker (*Catostomus commersonii*)	0.14 (0.12 - 0.15)	2	-	0
Rainbow trout (*Oncorhynchus mykiss*)	-	0	0.08 ± 0.02	5
Muskellunge (*Esox masquinongy*)	-	0	**0.91 ± 0.54**	10
Shortnose sturgeon (*Acipenser brevirostrum*)	-	0	**0.99 ± 0.57**	3
Striped bass (*Morone saxatilis*)	-	0	**1.64 (1.13-2.14)**	2

Notes:
Bold – Mercury concentration in tissue of some individuals exceeds Health Canada guideline of 0.5 mg/kg wet weight
- No data available
*Standard deviation of the mean (SD) is presented for species with more than three samples collected. Where two samples were collected the range of values is shown. Values are not standardized for a standard fish length and are therefore not directly comparable between species.

10.4 EFFECTS ASSESSMENT

The assessment of this VC will focus on examining the environmental effects associated with extending the operational life of MQGS (*i.e.*, MLAP) and does not consider potential effects associated with the original construction or existing operation of MQGS.

10.4.1 Assessment Criteria

This section describes the criteria used to assess environmental effects on the aquatic environment. Residual environmental effects (Section 10.3.4) are assessed and characterized using criteria defined in Section 10.4.1.1, including direction, magnitude, geographic extent, timing, frequency, duration, reversibility, and ecological or and socioeconomic context. The assessment also evaluates the significance of residual effects using threshold criteria or standards beyond which a residual environmental effect is considered significant. The definition of a significant effect for aquatic environment VC is provided in Section 10.4.1.2 below. Section 10.4.2 identifies the environmental effects to be assessed for the aquatic environment, including effect pathways and measurable parameters. This is followed by the identification of potential Project interactions with this VC (Section 10.4.2).

10.4.1.1 Residual Effects Characterization

Table 10.4 presents definitions for the characterization of residual environmental effects on the aquatic environment. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not practical.

Table 10.4 Characterization of Residual Effects on the Aquatic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to the aquatic environment relative to baseline **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to the aquatic environment relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Change in Fish Habitat Quality and/or Quantity** **Negligible –** no measurable change from baseline conditions **Low –** a measurable change in habitat area or monthly flows or habitat quality that is within the range of natural variability or less than 10% of mean annual flow (MAF) **Moderate –** a measurable change in habitat area or monthly flows or habitat quality that is greater than the range of natural variability and is >10% of MAF, however, that does not affect the ability of fish to use this habitat to carry out one or more of their life processes **High –** a measurable change in habitat area or monthly flows (>10%) or habitat quality that is greater than the range of natural variability and large enough that fish can no longer rely on this habitat to carry out one or more of their life processes
		Change in Fish Health and Survival **Negligible –** no measurable change in the abundance or survival of local fish populations **Low –** a measurable change in the abundance or survival of local fish populations that is within the range of natural variability **Moderate –** a measurable change in the abundance or survival of local fish populations that is greater than the range of natural variability. However, does not affect the sustainability of fish populations **High –** a measurable change in abundance or survival of local fish populations that is greater than the range of natural variability and is large enough to potentially affect the sustainability of fish populations
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the Project development area **LAA –** residual effects extend into the local assessment area
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** **Multiple irregular event –** occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously

Table 10.4 Characterization of Residual Effects on the Aquatic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term** – residual effect extends for less than 5 years during construction **Medium term** – residual effect extending five to fifteen years through the construction and into operation phases **Long term** – residual effect extends more than fifteen years through the operation phase **Permanent –** recovery to baseline conditions unlikely
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not Applicable –** Effect does not occur during critical life stage or timing does not affect the VC **Applicable –** Effect occurs during a critical life stage or timing affects the VC
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed after activity completion and rehabilitation
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Change in Fish Habitat Quality and/or Quantity** **Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present
		Change in Fish Health and Survival **Resilient –** populations are stable and able to assimilate the additional change **Not Resilient –** populations are not stable and are not able to assimilate the additional change because of having little tolerance to imposed stresses due to fragility or near a threshold

10.4.1.2 Significance Definition

A significant adverse residual effect on the aquatic environment is defined as one that results in one or more of the following:

- A Project-related HADD of fish habitat or the death of fish, as defined by the *Fisheries Act*, that cannot be mitigated, authorized, or offset
- A Project-related death of fish, as defined by the *Fisheries Act*, that cannot be mitigated, authorized, or offset
- A Project-related activity restricting the free passage of fish, as defined by the *Fisheries Act*

- A Project-related deposit of a deleterious substance into the aquatic environment which results in the death of fish or HADD of fish habitat, as defined by the *Fisheries Act,* that is not authorized and cannot be mitigated
- A change to the sustainability of fish populations or SAR/SOCC within the LAA where recovery to baseline is unlikely

10.4.2 Potential Project Interactions with the Aquatic Environment

Activities and components could potentially interact with the aquatic environment and result in adverse environmental effects. In consideration of these potential interactions, the assessment of Project-related environmental effects on the aquatic environment is therefore focused on the potential environmental effects listed Table 10.5. These potential environmental effects will be assessed in consideration of specific measurable parameters, also listed in Table 10.5.

Table 10.5 Potential Environmental Effects and Measurable Parameters for the Aquatic Environment

Potential Environmental Effect	Effect Pathways	Measurable Parameter
Change in fish habitat quantity	• In-water work • Change in fish passage • Change in water level or flow	• Area (m^2) of habitat
Change in fish habitat quality	• Alteration of riparian vegetation • In-water work • Erosion and sedimentation • Release of deleterious substances • Change in water level or flow	• Water quality, including but not limited to total suspended solids (TSS) (mg/L); dissolved oxygen (DO) (mg/L); water temperature (°C); pH; and sediment quality. • Fish habitat (physical characteristics), • Chlorophyll a (mg/L), Phytoplankton and zooplankton richness • Abundance of submergent aquatic macrophytes (m^2) • Density (individuals per m^2), richness, and community structure of benthic invertebrates • Species-specific sensitivities for species at risk (SAR) and species of conservation concern (SOCC)
Change in fish health and survival	• Use of industrial equipment in or near water • In-water work • Release of deleterious substances • Change in water level • Entrainment	• Direct and indirect mortality (numbers of fish) • Abundance and community structure • Bioaccumulation and/or biomagnification of metals • Species-specific sensitivities for species at risk (SAR) and species of conservation concern (SOCC)

Table 10.6 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 10.6 Potential Interactions Between Physical Activities and the Aquatic Environment

	Change in Fish Habitat Quantity	Change in Fish Habitat Quality	Change in Fish Health and Survival
Construction			
Site preparation	✓	✓	✓
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	✓	✓	✓
Isolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	-	-	-
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	-	-	-
Shut down of power units	✓	-	✓
Fish passage	✓	-	✓
Transportation (*powerhouse: transportation of equipment)*	-	-	-
Employment and expenditure	-	-	✓
Operation and Maintenance			
Operation of the MQGS	-	✓	✓
Maintenance of the MQGS	-	✓	✓
Fish passage	✓	✓	✓
Notes: ✓ = Potential interaction – = No interaction			

The following Project activities and components are not expected to result in a change in fish habitat quantity, change in fish habitat and quality, or change in fish health and survival:

- Isolated work in the dry during construction which will occur in isolation from the St. John River and will not interact with the aquatic environment
- Work above the water line which will occur above the existing high water line and/or in isolation from the St. John River and will not interact with the aquatic environment
- Transportation, since such activities will occur on land away from the St. John River

These potential interactions will not result in any interaction between the Project and the aquatic environment, are rated not significant, and are not discussed further.

10.4.2.1 Potential Effects to the Aquatic Environment During Construction

In the absence of mitigation, the construction of the Project could interact with the aquatic environment during construction which could result in changes in fish habitat quantity, fish habitat quality, and/or fish health and survival. These potential interactions are discussed in further detail below. No changes in water level beyond the normal operating limits are anticipated in Mactaquac headpond; therefore, no potential effects associated with the potential drawdown of Mactaquac headpond are anticipated for fish habitat quantity or fish health and survival.

Change in Fish Habitat Quantity

Site preparation and in-water works could potentially result in temporary or permanent alterations in fish habitat within the Mactaquac headpond and the St. John River within the PDA. These effects could occur from cofferdam construction while de-watering areas of the river to facilitate working in the dry; underwater work (where working in the dry is not practically feasible); or to provide access to the water upstream and downstream of the MQGS.

In-water work, isolated work in the dry and shut down of power units can result in short-term changes in fish passage (*e.g.*, water levels and locations of in-water works, attraction efficiency, temporary fish passage options) which could result in a change to the quantity of habitat available for fish to carry out their life processes during these short periods.

There are no changes in employment and expenditure that interact with fish habitat quantity.

Change in Fish Habitat Quality

Several Project-related activities could affect fish habitat quality during site preparation and in-water work including the use of industrial equipment, vegetation clearing, excavating and grading, water management, and concrete repairs. These activities can increase the potential for changes in runoff, erosion and sedimentation, and the introduction of deleterious substances into waters frequented by fish.

Construction activities during site preparation could interact with aquatic habitat through the use of heavy equipment (*e.g.*, excavators, clearing equipment) near the river. A potential interaction could occur between the aquatic environment from heavy equipment entering the river. Equipment entering a watercourse could result in changes in aquatic habitats through alterations in substrate and/or aquatic vegetation.

Introduction of deleterious substances (*e.g.*, grease, fuel, oil, drill water) from machinery operating in or near waterbodies could also affect fish habitat quality.

Removal of riparian vegetation during site preparation may reduce shade and, in turn, affect the quality of fish habitat through changes in overhead cover.

During site preparation and in-water work, the transfer of aquatic invasive species from equipment could result in a change in fish habitats. The transfer of non-native macrophyte species from equipment could change fish habitats through the quantity, cover and composition of macrophyte species. The transfer of other non-native aquatic organisms could result in changes in the abundance and community composition of primary and secondary producers.

The timing of construction for in-water work can also influence the potential environmental effects of the Project on fish habitat quality. For example, conducting site preparation or in-water work during high flow events or during periods of increased rainfall can increase the potential for runoff and the amount of sediment entering the aquatic environment. Site preparation activities could also result in an increase in erosion and sedimentation due to use of industrial equipment, removal of riparian vegetation or topsoils, presence of exposed soils, changing slopes, or drainage patterns. Sedimentation could affect fish habitat quality by depositing sediment in fish habitat, thus reducing habitat quality (*e.g.*, siltation of spawning beds, smothering of primary or secondary producers) (Greig *et al.* 2007; Wood and Armitage 1997; Kemp *et al.* 2011).

During in-water work, the release of untreated wastewater into the aquatic environment could affect fish habitat quality if suspended sediments and/or contaminants are released, which could affect the suitability of habitat for primary and secondary producers (Sweka and Hartman 2001; Herbert and Merkens 1961; Kjelland *et al.* 2015).

The shut down of power units, fish passage, and employment and expenditure are not anticipated to result in a change in fish habitat quality.

Change in Fish Health and Survival

Several Project-related activities could affect fish health and survival during site preparation and in-water work, including the use of industrial equipment, vegetation clearing, excavating and grading, and water management. These activities can increase the potential for erosion and sedimentation, and the introduction of deleterious substances which could affect the health and survival fish and SAR/SOCC.

Conducting site preparation or in-water work during high flow events or during periods of increased rainfall can increase the potential for runoff and the amount of sediment entering the aquatic environment. During site preparation and construction, the mobilization of sediments could inhibit the ability of fish to forage and cause behavioural or physiological changes in fish and smothering of eggs (Sweka and Hartman 2001; Herbert and Merkens 1961; Kjelland *et al*. 2015; Newcombe and Jensen 1996; DFO 2018). Fish eggs and larvae have been shown to be the life stage that is most sensitive to increased sedimentation through the reduction of water flow and oxygen delivery to eggs (Greig *et al*. 2007; Wood *et al.* 1997; Kemp *et al.* 2011).

In lower velocity areas, suspended sediments can settle out and smother benthic invertebrate communities or fish eggs and larvae (DFO 2018). If high volumes of fines (*i.e.*, silt, clay, and sand) are deposited, the voids in gravel and cobble bed materials might become embedded. Increases in embeddedness can affect the abundance and diversity of benthic invertebrate communities and availability of feeding and spawning areas for fish (DFO 2019b). Continuous, elevated sediment levels can result in reductions in primary and secondary productivity.

Equipment entering a watercourse for in-water works could result in the direct mortality or injury to fish or SAR/SOCC through physical contact.

Introduction of deleterious substances (*e.g*., grease, fuel, oil, and suspended solids) from machinery operating in or near waterbodies could also affect fish health and survival through the direct mortality or sub-lethal effects to fish and SAR/SOCC populations from exposure to deleterious substances.

During site preparation and in-water work, the transfer of aquatic invasive species (AIS) from equipment could result in a change in fish health and survival through changes in the abundance and community composition of local fish or SAR/SOCC through competition or predation.

The timing of construction can also influence the potential environmental effects of the Project on fish health and survival. Work conducted outside of the DFO/NBDELG timing windows may result in the direct mortality of fish larvae or eggs that are present during in-water work. Fish survival could also be affected by dewatering of areas of the river for in-water works.

During in-water work, the release of untreated water from areas requiring dewatering into the aquatic environment could affect the health and survival of fish and SAR/SOCC if suspended sediments and/or contaminants are released.

Noise and/or vibration from in-water works (*e.g.*, drilling/jackhammering may result in behavioural changes (*i.e.*, movements) or mortality to fish/SAR if the noise or pressure waves are of sufficient magnitude. Noise and vibration may deter fish from entering or migrating through the construction area, and mortality may occur from physical injuries as sound or pressure waves pass through the swim bladder. The distance which could result in an injury depends on a variety of factors such as depth and water temperature which diminish sound and the sensitivity of the organism. Sound levels vary based on the method of installation and the size of the hammer (Illingworth and Rodkin 2007). It is anticipated that sound levels capable of causing injury or mortality would have to occur in very close proximity to high intensity noise producing activities at the MQGS.

Water intakes used during construction could result in impingement or entrainment of aquatic organisms and thereby affect the health and survival of fish and SAR/SOCC.

Changes in fish passage and shut down of power units could result in a change in fish health and survival. Changes in the location of fish collection facilities, type of fish passage, and/or attraction velocities to the fish pass could result in migratory delay, inability to pass, injuries, physiological stress, or absorption of gametes if fish passage is not effective. There is the potential for reduced recruitment and a reduction in fish populations/SAR if fish are unable to reach areas important to carrying out their life history or experience elevated mortality during downstream migrations.

Changes in employment and expenditure associated with the commercial gaspereau fishery at MQGS could result from a change in fish health and survival.

10.4.2.2 Potential Effects to the Aquatic Environment During Operation and Maintenance

Change in Fish Habitat Quantity

During operation and maintenance, it is anticipated that the key Project interaction with fish populations and fish habitat will continue to be through ongoing effects to habitat connectivity (as currently) and ultimately restoring habitat quantity for species where fish passage was not previously facilitated (*e.g.*, American eel, sea lamprey, and American shad). The Project may result in positive changes in upstream fish passage at the MQGS from improvements or replacement of the existing fish passage structure (*e.g.*, fish lift) or changes in attraction flow.

There are no changes in water levels expected beyond the normal operating limits; therefore, no changes in fish habitat quantity are anticipated during operation and maintenance of the MQGS related to changes to water levels.

Change in Fish Habitat Quality

Operation and maintenance of the MQGS can interact with aquatic habitat upstream in the Mactaquac headpond and downstream in the St. John River through changes in flow and velocity, which could affect the quality of available fish habitats (*e.g.*, substrate, aquatic vegetation, water depth).

Any Project interactions with fish habitat quality that are associated with future in- or near-water maintenance activities are expected to be similar to those described for the construction phase (Section 10.4.2.1), and therefore are not discussed in more detail below.

Changes in operation and maintenance of the MQGS can result in changes in fish passage as a result of changes in the local hydrology (*e.g.*, flows and velocities) at the entrance to the fish collection facilities.

Change in Fish Health and Survival

Changes in the operation of the MQGS from the refurbishments (*e.g.*, enhanced fish collection facilities and turbine replacement) could result in changes in the health and survival of fish during upstream and downstream passage.

Any Project interactions with fish health and survival that are associated with future in- or near-water maintenance activities are expected to be similar to those described for the construction phase (Section 10.4.2.1; sedimentation and erosion, use of industrial equipment, introduction of deleterious substances, AIS and timing of construction), and therefore are not discussed in more detail below.

Changes in fish passage at the MQGS could lead to a change in fish health and survival due to changes in attraction flow efficiency, passage efficiency, and physiological stress which could result in migratory delays or absorption of gametes. There is the potential for changes in recruitment and a change in fish populations/SAR based on the ability of fish to reach upstream fish habitats important to carrying out their life history or as a result in changes in mortality during downstream migrations.

10.4.3 Mitigation for the Aquatic Environment

Interactions between Project activities and the aquatic environment will be managed in consideration of the environmental effects pathways. Mitigation measures will include standard, proven measures for sediment and erosion control, incorporating DFO standards and best management practices in consideration of regulations and guidelines that govern fish and fish habitat protection. Mitigation measures for the aquatic environment are identified in Table 10.7.

Table 10.7 Mitigation for the Aquatic Environment

Category	Mitigation	Construction	Operation and Maintenance
Site Preparation	• Project footprint and disturbed areas will be limited to the extent practicable.	✓	-
	• Movement of equipment/vehicles will be restricted to defined work areas and roads, and specified corridors between work areas.	✓	-
	• Maintain an undisturbed buffer of existing riparian vegetation, to the extent practicable.	✓	-
	• Standard erosion and sedimentation control structures will be used (*e.g.*, silt curtains, sediment control fences), inspected regularly, and maintained throughout construction activities. Sediment control fences will be removed following revegetation.	✓	-
	• Engineered surface water drainage and diversion channels will be constructed to impound site contact water and allow settling by gravity prior to release.	✓	-
	• Weather advisories will be followed, and work will be scheduled to avoid high precipitation and runoff events or periods to the extent practicable, to reduce potential for erosion/sedimentation.	✓	-
	• All equipment will be inspected and cleaned prior to use onsite to prevent the transfer of non-native species.	✓	-
	• Overburden storage piles and exposed topsoil will be placed away from bodies of water.	✓	✓
	• Waste material (*i.e.*, construction debris) will be contained and disposed of in an approved manner.	✓	✓

Table 10.7 Mitigation for the Aquatic Environment

Category	Mitigation	Construction	Operation and Maintenance
Works In or Near the Aquatic Environment	• In-water work will be planned to respect DFO timing windows to protect fish in New Brunswick (DFO 2019a), unless Authorized.	✓	-
	• The duration of in-water works will be minimized to the extent practicable and machinery will be operated above the high-water mark or inside of isolated areas, where practicable.	✓	-
	• In-water work sites will be isolated from flowing water (*i.e.*, by using a cofferdam) to the extent practicable. Clean, low permeability material and rockfill will be used to construct cofferdams.	✓	-
	• Surplus or sediment-laden water will be controlled and treated prior to release (*e.g.*, filtration through vegetation or engineered erosion control devices or settling ponds).	✓	-
	• Fill (*e.g.*, gravel) placed in or next to the river will be free of debris, fine silt and sand, and chemical contaminants.	✓	✓
Works In or Near the Aquatic Environment	• Best efforts will be made by a qualified environmental professional to relocate fish/SAR from areas of in-water works or riparian areas to the extent practicable.	✓	-
	• Fish screens and/or other barriers will be installed and maintained to prevent fish from entering water intakes.	✓	✓
	• Existing flow conditions will be maintained to the extent practicable.	✓	✓
	• Fish passage will be maintained or improved for Atlantic salmon, alewife, and blueback herring and potentially improved for American shad, American eel, and sea lamprey. – During construction fish passage will be maintained through the existing trap-and-truck facility or temporary floating guidance boom – The existing upstream fish passage facilities will be enhanced through upgrades, replacement or modifications, and a new eel ramp – Downstream passage may include selection of turbine equipment, installation of a floating guidance boom and bypass or floating surface fish collector	✓	✓
	• Where HADD of fish habitat or the death of fish cannot be avoided, the habitat will be offset, as required by the *Fisheries Act*, through the development and implementation of a Fish Habitat Offsetting Plan.	✓	✓

Table 10.7 Mitigation for the Aquatic Environment

Category	Mitigation	Construction	Operation and Maintenance
Materials Handling and Waste Management	• Temporary on-site sewage systems will be installed and operated according to relevant provincial legislation.	✓	-
	• All fuels and lubricants used during construction will be stored according to regulated containment methods in designated areas. Storage areas will be located at least 30 m from watercourses, wetlands, and water supply areas (including known private wells).	✓	✓
	• Refueling of machinery will not occur within 30 m of watercourses and water supply areas to reduce the likelihood that deleterious substances will enter watercourses. Where stationary equipment is situated, special precautions will be implemented to prevent spills during refueling. Spill response kits will be located at the refueling site.	✓	✓
	• Disposal and handling of waste oils, fuels, and hazardous waste will be as recommended by the suppliers and/or manufacturers in compliance with federal, provincial, and municipal regulations.	✓	✓
Notes: ✓ = Interaction - = No interaction			

10.4.4 Characterization for Residual Project Environmental Interactions for the Aquatic Environment

This section discusses the residual Project-related residual effects to the aquatic environment following the application of mitigation in Section 10.4.3.

Change in Fish Habitat Quantity

Pathways that affect fish habitat quality as outlined in Section 10.4.2.1 and 10.4.2.2 are primarily related to areas of in-water works including repairs of the water intake structure, main spillway and diversion spillway and water access, and fish passage which could affect the quantity of available fish habitats upstream of MQGS.

Where avoidance is not feasible, mitigation will be employed to reduce the potential for effects as described below. Project-related effects to fish habitat quantity are reduced through the application of best practices in accordance with DFO's "*Measures to Protect Fish and Fish Habitat*" (DFO 2019a). When working near water, DFO standards and codes of practice will be used to reduce the potential for change in fish habitat quantity.

Where residual adverse effects remain following the application of mitigation, these must be counterbalanced by offsetting through an authorization pursuant to the *Fisheries Act*. The Offsetting Plan will consider input from consultation and engagement (*e.g.*, Indigenous groups and CRI) and will be developed and implemented in consultation with DFO and in consideration of the "*Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act*" (DFO 2019b).

As changes in water level within the headpond are anticipated to be within the normal operating approved range, no additional loss in fish habitat or primary and secondary production is anticipated within Mactaquac headpond. It is possible that the Project will result in the temporary or permanent loss of fish habitat associated with in-water works (*e.g.*, cofferdam construction, underwater work, or water access) or the use of temporary facilities during construction. Details will be refined during final Project design and discussed with DFO. Any HADD of SAR and fish habitat will be counterbalanced with an authorization under Section 35(2) the *Fisheries* Act and associated Offsetting Plan (at the discretion of DFO).

The Project includes two distinct phases for fish passage: 1) temporary, during construction activities and 2) long-term, for the operational lifespan of the MQGS. No net loss in habitat connectivity from the Project is anticipated beyond that which currently exists.

Current functional fish passage, which sustains a healthy, naturally reproducing population, will be maintained or improved during construction and operation and maintenance for Atlantic salmon, alewife, and blueback herring. Fish passage will be improved for American eel, American shad, and sea lamprey during operation and maintenance so that they can also access the necessary upstream habitats required for life processes. Any improvements to fish passage for American eel, American shad, and sea lamprey during operation and maintenance will result in improved habitat connectivity.

CRI and Kleinschmidt have studied and continue to conduct studies in support of temporary fish passage, and a long-term enhanced multi-species functional fish passage solution for both upstream and downstream at MQGS. This research has informed fish passage strategies and options discussed below.

During construction, NB Power is committed to providing fish passage that is similar to what occurs at present (*i.e.*, for Atlantic salmon, alewife, and blueback herring), through the existing trap-and-truck facility and the temporary floating guidance boom described in Section 2.4.7.

The temporary passage system cannot be installed year-round due to ice, debris, and flow conditions in the St. John River during the winter months and spring freshet. Instead, the temporary upstream passage system will target key migratory periods. It is anticipated that in a typical year of river flows this temporary passage system will be deployable by mid-June, or approximately the time that the existing collection facility is no longer useable due to Project construction activities. Since it is anticipated that the gaspereau passage objective will have been met by this time, the temporary passage system will be designed and operated solely to pass Atlantic salmon. This will have the added benefit of allowing for a larger net mesh size which will reduce drag and allow smaller bodied fish to pass downstream unimpeded.

As described in Section 2.4.7, an Adaptive Fish Passage Plan will be developed.

During operation and maintenance, upstream fish passage will also be enhanced (facilitating the passage of American eel, American shad, and sea lamprey) (Kleinschmidt 2021). The existing fish passage facilities will be modified and expanded to improve fish attraction and passage efficiency while reducing migratory delay and crowding. This will be accomplished by:

- Upgrading the auxiliary pumps and distribution piping to double the attraction flow at the entrance of the fish collection facilities
- Replacing the crowder trap gates with a V-shaped trap gate and enlarging the gate opening to reduce water velocity at the entrance of the crowder trap, and the crowder trap gate will have an adjustable width opening to facilitate passive sorting of fish by size, if required
- Replacement of brail gates to control the number of gaspereau entering the brail chambers and hoppers to reduce crowding
- Replacement of the hopper gate and brail so that the hopper and brail can move up and down simultaneously and be more mechanically resilient
- Replacement of the existing lifting tower and hoist to accommodate new hoppers which will increase water volume and reduce crowding
- Modification of the hopper to discharge from the side into a chute or pipe instead of the bottom
- Modifications to allow simultaneous operation of both hoppers which will reduce the cycle time of the fish passage facilities
- Sorting tanks to passively sort species, and assist in meeting management/monitoring objectives, particularly during the gaspereau season
- An additional truck to transport fish upstream to increase overall fish passage capacity and reduce crowding, which will result in a doubling of gaspereau transport capacity from current levels
- Refurbishing the structural and mechanical components of the existing fishway as required
- New wall-mounted eel ramp fish passage facilities for juvenile American eel

Downstream fish passage during construction and operation and maintenance will be maintained as it is currently through the turbines, or via the spillway/sluiceway when water is being spilled. Long-term downstream fish passage options during operation and maintenance are also being considered. As described in Section 2.5.3, NB Power's overall objective is to provide functional downstream passage for selected diadromous fish species while maintaining the ability to facilitate future changes in target species and their associated management objectives. Three alternatives for long-term downstream fish passage are currently being evaluated:

1. Selection of turbine equipment with improved fish survival rates
2. Installation a floating guidance boom and bypass
3. Installation of a floating surface fish collector

These fish passage enhancements are most applicable to surface-oriented species such as salmonids. An adaptive management plan for downstream fish passage for American eel will also be implemented as this species is not surface-oriented. The adaptive management plan will investigate downstream fish passage mechanisms specific to this species and include studies on eel prevalence upstream of the MQGS and migration timing (Kleinschmidt 2022). The Adaptive Fish Passage Plan will develop thresholds and consider adaptive approaches to fish passage in the event that temporary or permanent fish passage facilities do not function as intended.

Change in Fish Habitat Quality

Pathways that affect fish habitat quality as outlined in Sections 10.4.2.1 and 10.4.2.2 are primarily related to site preparation and in-water work including the use of industrial equipment, vegetation clearing, excavating and grading, and water management.

Where avoidance is not feasible, mitigation (Section 10.4.3) will be used to reduce the potential for effects to fish habitat quality and effects to primary and secondary productivity. When working in or near water, interactions with the aquatic environment are well known and documented, and DFO standards and codes of practice will be followed. Consequently, with the application of best practices in accordance with DFO's *Measures to Protect Fish and Fish Habitat* (DFO 2019a), Project-related effects on fish habitat quality, including primary and secondary producers, will be mitigated during construction and are not anticipated to be substantially different from existing conditions during operation and maintenance; therefore, no residual effect is predicted, and a change in fish habitat quality is not discussed further in this EIA Registration.

Change in Fish Health and Survival

Pathways that affect fish health and survival as outlined in 10.4.2.1 and 10.4.2.2 are primarily related to changes in fish passage which could affect fish health and survival.

Construction for in-water works will be conducted in respect of the DFO timing windows for New Brunswick, to the extent practicable, thereby protecting fish and avoiding direct mortality of fish larvae or eggs. Rescue activities will be completed for fish and SAR prior to in-water works to the extent practicable to avoid the death of fish and SAR.

During operation and maintenance, the water intake structure can entrain fish and affect fish health and survival. Young, small-bodied fish with poor swimming abilities are more susceptible to entrainment than larger adult fish (DFO 1995). As there are no changes in the operation or maintenance of MQGS, no changes in the entrainment of Atlantic salmon, alewife, and blueback herring are anticipated compared to that arising from the current operation and maintenance of the MQGS. As upstream fish passage will be improved for American shad, American eel, and sea lamprey, it is anticipated that there will be an increase in entrainment and mortality of these species compared to existing conditions during their downstream passage (as there is currently no, or only incidental, passage). Where residual adverse effects remain following the application of mitigation, these must be counterbalanced by offsetting through an authorization pursuant to the *Fisheries Act* for the "death of fish." Overall, the passage of American shad, American eel, and sea lamprey is anticipated to result in net benefits to their local populations.

During the construction phase, as described in Section 10.4.4, it is anticipated that fish passage will be similar to that which currently occurs for Atlantic salmon, alewife, and blueback herring. As a result, no change in fish health and survival is anticipated.

During the operation and maintenance phase, as described in Section 10.4.4, it is anticipated that upstream fish passage will be similar to or improved relative to what occurs at present (for Atlantic salmon, alewife, and blueback herring) and enhanced for three additional species. The existing fish passage facilities will be modified and expanded to improve fish attraction and passage efficiency and reduce migratory delay and crowding. As a result, these improvements in fish passage are anticipated to result in positive effects to fish health and survival during operation and maintenance.

Summary

A summary of the residual environmental effects on the aquatic environment during Project construction and operation and maintenance is provided in Table 10.8.

Table 10.8 Project Residual Effects on the Aquatic Environment

Residual Effect	Residual Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Fish Habitat Quantity	C	A	L	PDA/LAA	P	A	IR	I	D
	O	P	N	LAA	LT	A	C	R	D
Change in Fish Habitat Quality	C	A	N	PDA	MT	A	IR	R	D
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Change in Fish Health and Survival	C	A	L	PDA	MT	A	IR	R	R
	O	A/P	M	RAA	LT	A	R	R	R

KEY:
See Table 10.4 for detailed definitions

Project Phase
C: Construction
O: Operation and Maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area

Duration:
ST: Short term
MT: Medium term
LT: Long term
P: Permanent

Timing:
NA: Not Applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
Change in Fish Habitat Quality and/or Quantity:
D: Disturbed
U: Undisturbed
Change in Fish Health and Survival:
R: Resilient
NR: Not resilient

N/A: Not applicable

10.5 DETERMINATION OF SIGNIFICANCE

The determination of significance focuses only on extending the operational life of MQGS (*e.g.*, MLAP) and the related activities during construction and operation and maintenance of the refurbished MQGS. With the implementation of mitigation and environmental protection measures as described in this assessment (for construction, and operation and maintenance), it is anticipated that the residual adverse environmental effects of the Project on the aquatic environment will be not significant. This is because: 1) Project-related HADD or the death of fish, as defined by the *Fisheries Act,* will be authorized and offset; 2) the commitments to improve fish passage for species requiring functional fish passage; 3) the deposit of deleterious substances into the aquatic environment is not anticipated with the proposed mitigation (except as an accident, malfunction, or unplanned event that is discussed in Chapter 18); and 4) no negative changes in the sustainability of fish populations or SAR/SOCC within the LAA are anticipated.

With mitigation, offsetting, and environmental protection measures in place, the residual adverse environmental effects of the Project on the aquatic environment during all phases are predicted to be not significant, with a high level of confidence. Best management practices and the use of standard mitigation will be followed for work in or near water during construction.

Any habitat loss or disturbance will be within the immediate Project footprint. Fish habitat that is lost from the Project will be counterbalanced through implementation of a Fish Habitat Offsetting Plan to be developed in consultation with DFO and stakeholders. The Offsetting Plan will include follow-up monitoring to confirm that the required offset is achieved, and contingency measures if the offsetting is not as successful as planned.

During construction, it is anticipated that fish passage will be maintained and subsequently enhanced during operation and maintenance. An Adaptive Fish Passage Plan will also be developed in the event that temporary or permanent fish passage facilities do not function as intended.

10.6 FOLLOW UP AND MONITORING

Follow-up and monitoring are intended to verify the accuracy of predictions made during the EIA Registration, to assess the implementation and effectiveness of mitigation and the nature of the residual effects, and to manage adaptively, if required. Compliance monitoring will be conducted to confirm that mitigation measures are properly implemented. Should an unexpected deterioration of the environment be observed as part of follow-up and/or monitoring, intervention mechanisms will include the adaptive management process. This may include an investigation of the cause of the deterioration and identification of existing and/or new mitigation measures to be implemented to address it.

Follow-up and monitoring plans to be implemented for the aquatic environment include:

- Environmental monitoring during construction and operation and maintenance to follow up on effectiveness of the Erosion and Sediment Control Plan
- Surface water quality monitoring, as described in the Surface Water Monitoring Plan

- Compliance and effectiveness monitoring of the Offsetting Plan upon implementation, as authorized under the *Fisheries Act*
- Adaptive Fish Passage Plan to follow up on effectiveness of fish passage during construction and operation

The Adaptive Fish Passage Plan will be developed for construction and the long-term operation and maintenance of the refurbished MQGS fish passage facility. The Adaptive Fish Passage Plan will be developed following the established framework for functional fish passage decision making (Dolson *et al.*, 2021). Functional fish passage will be designed to facilitate fish passage for Atlantic salmon, alewife, and blueback herring during construction and operation and maintenance as well as American eel, American shad, and sea lamprey during operation and maintenance.

The Adaptive Fish Passage Plan will:

- Establish objectives, and quantitative targets and metrics (*e.g.*, numbers of fish passing upstream or fish mortality)
- Establish methodology to monitor fish passage performance
- Outline operating plans for fish passage facilities and MQGS as it pertains to fish passage
- Assess the outcomes of management options for fish using a quantitative approach
- Include adaptive management in the event that the proposed fish passage facilities do not function as intended or there are negative effects to fish health and survival as a result of operations (*e.g.*, as a result of downstream passage through spillways or hydraulic conditions)
- Consider ecological and economical solutions

10.7 REFERENCES

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11.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON HERITAGE RESOURCES

This section includes an analysis of potential environmental interactions between construction and operation and maintenance of the Mactaquac Life Achievement Project (MLAP; “the Project”) and heritage resources.

11.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

Heritage resources are those resources related to activities from the past that remain to inform present and future societies of that past. Heritage resources are relatively permanent, although highly tenuous, features of the environment. If present, their integrity is highly susceptible to construction and ground-disturbing activities.

Project activities that include surface or sub-surface ground disturbance can interact with heritage resources, where these resources are present. Construction therefore represents the Project phase with the greatest potential for interaction with heritage resources through ground-breaking and earth moving.

Undocumented heritage resources, where present, are typically located on or in the soil or rock layers of the earth. If heritage resources are present within the Project development area (PDA) for this Project, interactions would be anticipated only during construction as this is the only phase of the Project where surface or sub-surface ground disturbance is anticipated. Heritage resources are known to be present within the PDA and may require additional mitigation before any ground disturbing construction activities can begin. A management plan will be in place should any unknown resources be discovered during construction.

Heritage resources has been selected as a valued component (VC) in recognition of the interest of provincial and federal regulatory agencies who are responsible for the effective management of these resources as well as the general public and First Nations that have an interest in the preservation and management of heritage resources related to their history and culture.

This assessment considers potential changes to heritage resources from the Project. The scope of the assessment is based on applicable regulations and policies, professional judgment of the study team, and knowledge of potential interactions.

11.2 SCOPE OF ASSESSMENT FOR HERITAGE RESOURCES

11.2.1 Regulatory Context

Heritage resources in New Brunswick are regulated under the *Heritage Conservation Act* (2010). The regulatory management of heritage resources is the mandate of the New Brunswick Department of Tourism, Heritage and Culture, and is administered by its Archaeology and Heritage Branch (AHB) (for archaeological resources), Historic Places Section (for built heritage resources), and Natural Sciences Section (for palaeontological resources).

The assessment for heritage resources has been undertaken through the completion of historical, archaeological, built heritage, and palaeontological research. The Province of New Brunswick provides guidance for conducting archaeological impact assessments, such as the *Guidelines and Procedures for Conducting Professional Archaeological Assessments in New Brunswick* (the “Archaeological Guidelines”; AHB 2012).

Consultation and engagement activities have occurred as part of the heritage resources component of the Project. During the background research for heritage resources, regional experts and regulatory agencies were contacted to gather information on potential heritage resources within the PDA.

11.2.2 Spatial Boundaries

The assessment of potential environmental interactions between the Project and heritage resources is focused on a PDA and a local assessment area (LAA).

The PDA for the Project is defined as the area of physical disturbance associated with the construction and operation of the Project. The PDA is described in Section 2 and depicted on Figure 2.1.

The LAA for heritage resources is defined as the area within which the environmental effects of the Project can be measured or predicted and can be thought of as the “zone of influence” of the Project on heritage resources. The LAA for heritage resources is the same as the PDA, as it is only within the PDA that construction and ground-disturbing activities could interact with heritage resources. Heritage resources located outside of the PDA are discussed in the “existing conditions” section below only to inform this assessment regarding the potential for unknown heritage resources within the PDA. However, the resources outside the PDA will not be directly affected by the Project and are not considered further in this assessment.

The PDA/LAA for heritage resources is shown on Figure 2.1.

11.2.3 Temporal Boundaries

The temporal boundaries for this assessment considers the timeframe when potential environmental effects on heritage resources could take place. For this Project, that timeframe is:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years.
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068.

Any effects on heritage resources are to be considered permanent because they cannot be returned to their original condition.

11.3 EXISTING CONDITIONS FOR HERITAGE RESOURCES

11.3.1 Approach and Methods

Information on the existing conditions (*i.e.*, known information) regarding heritage resources was gathered through a combination of documentary research, consultation, and Archaeological Impact Assessments (AIA) conducted within the PDA in 2016, 2018, and 2019 (Stantec 2017, 2019, and 2020). A First Nations monitor was present during the AIAs.

The following sources were consulted to gather an understanding of the general and specific history of the PDA:

- Published, unpublished, and online works about local history, the environment, and previous archaeological work carried out in the area
- The Archaeological Potential Map of the area of review, provided by AHB (AHB 2016), which depicts areas with high and medium potential for archaeological resources, based on anthropological, geographic, and geological data
- Provincial archaeological sites database (*e.g.,* Maritime Archaeological Resource Inventory (MARI) forms)
- Reports on file at AHB
- Representatives from AHB
- Documents in the Provincial Archives of New Brunswick (PANB)
- Department of Natural Resources historic aerial photographs
- The Canadian Register of Historic Places and the New Brunswick Register of Historic Places databases

For information regarding archaeological resources, AHB was contacted ahead of the 2016 and 2018 AIAs to request an updated Archaeological Potential Map for the PDA and surrounding areas. The Archaeological Potential Map presents information from a variety of heritage related and environmental databases, as well as identifies areas with elevated potential for archaeological resources. Typically, the shoreline areas of all watercourses and coastlines are considered by AHB as having either “high” potential (0–50 m from the watercourse bank or coastline) or “medium” potential (50–80 m from watercourse bank or coastline) for pre-contact archaeological resources. Confluences of any two watercourses are considered to have “high” potential for pre-contact archaeological resources within 100 m from the watercourse banks. Also included are potential palaeo-shorelines that may have been present as early as 13,000 years before present. Together, these areas are referred to as elevated potential zones.

The field component of the AIAs involved an archaeological field survey (walkover) of the entire PDA, including sections of the PDA that were later discarded from the Proponent’s preferred siting locations. The PDA was assessed via walkover in consideration of the results of the Archaeological Potential Map data (AHB 2016) and following the *Guidelines and Procedures for Conducting Professional Archaeological Assessments in New Brunswick* (the Guidelines) (AHB 2012), as well as the professional judgment of the Stantec Archaeology Team. Walking pre-defined transects within the PDA, any areas of elevated potential for archaeological resources were identified. Where they occurred, these areas were delineated and labeled as “Polygons” using handheld GIS devices with 3-5 m accuracy. Polygons are typically identified for additional archaeological mitigation (*e.g.*, shovel testing).

In addition to the 2016 AIA which involved a walkover survey of the Project PDA (Stantec 2017), a separate AIA was conducted in 2018-2019 that included walkover of a smaller portion of the PDA (Stantec 2019). This was followed up by archaeological mitigation through shovel testing at areas within the PDA identified as having elevated archaeological potential for historic period archaeological resources (Stantec 2020). These AIAs were completed under a permit issued by AHB to a provincially permitted archaeologist who supervised and completed the work as required under the Guidelines (AHB 2012). Field-based components of the AIAs were accompanied by an NB Power First Nations Monitor. The results of these AIAs are described below.

Built heritage resources are typically identified through a review of federal and provincial databases for built heritage resources.

A report on the geology of the PDA provided information on the potential for fossils to be present in bedrock layers that may be encountered during construction. The results of this report are described below.

11.3.2 Description of Existing Conditions

The sections below describe the existing conditions for heritage resources. Archaeological resources, built heritage, and palaeontological resources were considered when describing existing conditions as part of this VC.

11.3.2.1 Setting

The PDA is located entirely within the Aukpaque Ecodistrict of the Grand Lake Lowlands Ecoregion. This ecodistrict encompasses most of the Lower St. John River Valley from approximately 16 km west and upriver to approximately 95 km downriver of the PDA and includes the Oromocto River drainage.

The landscape of this ecodistrict is dominated by the St. John River (Wolastoq), its tributaries and the valley through which the river flows. The river overflows annually during the spring freshet and deposits alluvial material on top of glacial sediments as old as 12,000 years (NBDNR 2007). These glacial sediments were deposited in the early Holocene (11,700 years ago to present-day) when an ice dam formed near the city of Saint John, creating a glacial water body known as Glacial Lake Acadia. Once the ice broke up, the water forming this lake flowed out and into the Bay of Fundy. Due to its broad flood plain and valley, the St. John River has constantly worked and reworked its riverine and old lacustrine sediments into a chain of shifting alluvial islands. Several major watercourses enter the St. John River in this ecodistrict including the Nashwaak River, Mactaquac Stream (now partially submerged upstream of the MQGS), Keswick River, and Oromocto River. Topographic relief in the ecodistrict is generally low with elevations of 100 m above mean sea level (m amsl) in the eastern portion and reaching to 150 m amsl in the west. Currie Mountain (elevation = 84 m amsl), west of Fredericton, is one such high point of relief and is comprised of mafic volcanic materials (NBDNR 2007).

The PDA is located in a relatively uniform geological setting, with very few features located within the PDA. The bedrock base is characterized by Silurian-aged Kingsclear Group, Burtts Corner formation, which includes light grey, medium- to coarse-grained wacke, noncalcareous siltstone and shale (St. Peter and Fyffe 2005). The surficial geology of the PDA and surrounding area is characterized by a lag deposit of sandy or stony till veneer diamicton (*i.e.*, sediments originating during Pleistocene glaciation) occurring in patches over rock and reworked by glaciolacustrine or glaciomarine processes. An extensive alluvial floodplain deposit is present within the PDA along the south bank of the St. John River, downstream of the MQGS (Allard and Gilmore 2016).

11.3.2.2 Archaeological Resources

Pre-Contact Period

The 1968 construction activities related to the MQGS resulted in significant disturbance to the landscape in proximity to the MQGS. It further resulted in the flooding of former shorelines and low-lying areas along the boundaries of the pre-MQGS St. John River, thereby preventing potential archaeological survey and research from being carried out in the area now occupied by the MQGS headpond. The 1968 construction occurred at a time when modern regional archaeological research was just starting in New Brunswick. Prior to this time, sporadic surface-collection and excavations had been conducted by natural historians during the late-19th and early-20th centuries and, later, by amateur archaeologists.

The Pre-Contact Period is often divided into four general cultural periods:

- Palaeoindian Period (13,000–9,500 years before present (BP))
- Archaic Period (9,500–3,000 years BP)
- Maritime Woodland Period (3,000–500 years BP)
- Proto-historic Period (approximately 500-370 years BP)

The Palaeoindian Period (13,000 – 9,500 years BP)

The Palaeoindian Period was the earliest period of human occupation in New Brunswick. It occurred during a time of extreme environmental and geographic change in the region immediately following the melting of glaciers in New Brunswick, the exact nature of which is not well understood. At the end of the last glaciation, a general warming trend began and the glaciers that covered all the lands that would become New Brunswick began to break apart. By 12,000 years BP, most of the interior portions of New Brunswick, including the current location of the headpond, were ice-free (Shaw *et al.* 2006). The mixture of forest and open habitats during this period created favourable conditions for caribou herds (Newby *et al.*, 2005) and other small and large mammals. These animals are believed to be the primary food sources for people during the Palaeoindian Period that were moving into, and living in, what is now central New Brunswick at that time.

Following the melting of the glaciers, and possibly due to the changes in sea levels and land elevations, there was a large inland water body, called Glacial Lake Acadia, in what is now central New Brunswick, generally centred over the current Grand Lake area (NBDNR 2007). The water level in the St. John River was much higher during the early post-glacial period than it was in the centuries before the MQGS was constructed. It may be the case that the current headpond levels are at a similar level to where the river was during the period immediately following the deglaciation of the Maritimes.

A review of provincial Archaeological Potential Mapping (AHB 2016) shows potential palaeo-shorelines within the PDA that may have been conducive to past human activity during the Palaeoindian Period and are considered to have elevated potential for sub-surface archaeological resources. These potential former shorelines are limited to the outside edges of the prominent landform north-northeast of the dam (*i.e.*, where the access road and switching substation are found) at elevations ranging from 28 to 48 m amsl.

To date, the only confirmed Palaeoindian Period artifact from the headpond area is a single fluted point recovered near Bilijk (Kingsclear First Nation) by a private collector (Turnbull 1974; Erickson 2007). This "Kingsclear point", as it is known, is associated with the Early Palaeoindian Period (*i.e.*,11,000 years BP or more) (Bradley *et al.* 2008).

The Archaic Period (9,500 – 3,000 years BP)

The Archaic Period starts with the end of the Palaeoindian Period and extends until approximately 3,000 years BP. The Archaic Period is further subdivided based on changes in material culture, particularly tool type, into different periods (Early, Middle, Late, and Terminal). The Archaic Period is usually identified by the presence of tools that differ from those of the Palaeoindian Period. A higher proportion of ground stone tools relative to flaked stone tools are characteristic of the Archaic Period (Robinson 1992). Stone artifacts from the Archaic Period were discovered in the current headpond along the shorelines of the St. John River (Pearson 1968) before the construction of the MQGS.

In the Middle Archaic Period, slate tools, choppers, and net weights first appeared (Robinson 1992), while in the Late Archaic Period, an increased proportion of knives, plummets, and slate points (Sanger 2008) were introduced. Large, side-notched projectile points were also adopted during the Late Archaic Period.

The Terminal Archaic Period is characterized by the appearance of stemmed projectile points, flaked stone drills, end scrapers, soapstone pottery, and distinctive grooved axes (Sanger 2008).

Numerous artifacts from the Late Archaic Period have been found in the portion of the St. John River now occupied by the headpond (McIntosh no date (n.d.)). One of the most significant Late Archaic Period finds in the headpond was from a terrace opposite the mouth of the Eel River at Meductic. This very rich archaeological site served as one of the most important Wolastoqiyik settlements on the St. John River and was used for an extensive period, including the Pre-Contact, Proto-Historic and Historic Periods. Prior to the flooding of this location, Pre-Contact artifacts could be found eroding from virtually every point along the shoreline at this location, where *"literally thousands of chippings, many whole and broken artifacts, pottery shards, fire and food pits, [and] burned beach stones"* could be found (Clarke 1970, p. 41–42). Clarke also notes that *"on practically every yard of the three terraces one finds flint flakes and fire-stones where wigwams once stood"* (Clarke 1970, p. 43). Other archaeological sites from the Archaic Period have also been documented within the headpond, including at the outlet of Lane's Creek, located north of Woodstock, where *"literally bushels of large broken and chipped flint stones"* were found (Clarke 1970, p. 152).

Animal remains recovered from Archaic Period archaeological sites suggest a focus on living near interior waterways and wetlands (Robinson 1992; Petersen 1991; Spiess and Mosher 2006). Other Archaic Period sites are located on the floodplains of major watercourses and on the margins of lakes and wetlands (Suttie 2005; Tuck 1993).

The Maritime Woodland Period (3,000 – 500 years BP)

During the Maritime Woodland Period (Woodland Period), New Brunswick's climate is believed to have been largely similar to present-day conditions; among other waterbodies, the St. John River stabilized to its pre-MQGS levels (Blair 2004). Most pre-contact archaeological sites in the province have been dated to this period, based on the type of stone tools identified as well as evidence from style and dates of pottery found (Petersen and Sanger 1993; Rutherford 1993).

One of the richest known Woodland Period sites located along the shoreline of the historical St. John River is the site at Meductic, which stood at the end of an ancient portage route. Here, historian Dr. George Frederick Clarke recovered *"many pottery shards, part of the bowl of a stone pipe, a large stone knife, arrowheads, knives, and a fine spearhead"* and several copper objects including *"bits of copper, two arrow or drill points…and a cylindrical bead of copper"* (Clarke 1970, p. 42).

Another Woodland Period site is located on the southwestern tip of Eqpahak Island, located approximately 5 km down river of the MQGS. Here, *"…a stone ax, arrow heads, [and] chips giving evidence of an Indian encampment having been situated here in former times"* (McIntosh n.d.). As well, staff from AHB surface-collected *"…pottery fragments, three flakes, a water-worn axe, a chopper and a hammerstone"* and an excavation unit yielded *"a scraper made of red material and a few fire-cracked rocks"* (Ferguson 1982, p. 4–5).

Pearson (1960–1962) reports that an Indigenous gravesite near Woodstock was destroyed during gravel removal, uncovering human remains and corner-notched projectile points. Another possible burial was located by Clarke at Lane's Creek, north of Woodstock on the east side of the St. John River. Here, Clarke reports finding *"fifteen knives and arrowpoints and one spearhead"* in an ashy deposit within a 1.8 m radius (Clarke 1970, p. 152). He describes the "spearhead" as corner-notched, suggesting a Late Woodland Period affiliation.

The Proto-Historic Period (circa [ca.] 500 – 370 years BP)

The period from approximately 600 to 400 BP is known as the Proto-Historic Period (Whitehead 1993), and generally refers to a period of transition whereby the traditional lifeways of pre-European (Pre-Contact) Indigenous persons in the Maritime provinces were disrupted by the arrival of Europeans but prior to sustained European settlement. During this time, Portuguese, French, and English fishers and explorers made expeditions into the Maritimes and began interacting and trading with Indigenous populations first on the coast, and then throughout the Wabanaki homeland from Maine and Québec throughout Atlantic Canada (Bourque and Whitehead 1985). Although there is little documentation around the degree of contact Europeans had with local Indigenous peoples (including the Wolastoqey), contact is suspected to have been extensive. During this time, the introduction of European trade goods, diseases, and religion began to have profound effects on Indigenous lifeways.

The PDA is within the traditional territory of the Wolastoqey people. Much of the livelihood efforts of the Wolastoqey were focused on major river systems because this was a primary mode of travel. Wolastoqiyik used the rivers and streams as their highways, travelling up the smallest of watercourses to access food and other resources. Due to its size and the fact that it covers such a large land area, the St. John River was considered the main travel route. It provided access to a vast territory of land but also, through it and its tributaries, to virtually any location in what is now known as Maine and the Maritimes, including the Bay of Fundy and Gulf of Saint Lawrence. It also provided bountiful resources for hunting, fishing, trapping, and other subsistence activities for Indigenous people.

Wolastoq (St. John River), meaning the "beautiful river", was the site of villages, camps, and an incredibly diverse range of activities represented by a variety of archaeological site types, located throughout its watershed (Wallis and Wallis 1957). Several Indigenous village and camp sites occupied during the Proto-historic Period have been identified in the portion of the St. John River that is now submerged by the headpond, including at the mouth of the Meduxnekeag River (*i.e.,* present-day Woodstock), Meductic, and Middle Southampton (Ganong 1899). The most important Wolastoqiyik settlement during the Proto-historic Period was at Meductic. Several writers in the 17th century describe an Indigenous fortification, village, and burial ground at this location (Brodhead 1855; Ganong 1899; Gyles 1736; Webster 1934).

Recovery excavations at Meductic undertaken in1964 by Louis R. Caywood of the United States National Parks Service prior to the construction of the MQGS (Rick 2006) uncovered numerous fire-pits, burned rocks, and post-molds, marking the remains of Indigenous wigwams from the Historic Period (Caywood 1969). According to oral tradition, several battles were fought at Meductic and the remains of the dead were buried on both sides of the river (Raymond 1897).

Registered Pre-Contact Archaeological Sites

There are no registered Pre-Contact Period archaeological sites within the PDA.

Historic Period

The Historic Period of the region starts in 1604 following the first contact of Indigenous peoples with European explorers (and later settlers), but there was little non-Indigenous settlement in and around the PDA until much later (described in the sections below).

French Settlement (up to 1758)

The earliest examples of European presence in the headpond area are the French missionaries who worked with Indigenous peoples at Fort Meductic (located near the confluence of the Eel River and St. John River) under the support of the Bishop of Québec. Although originally established by Wolastoqiyik as a village extending into the Pre-Contact Period, Meductic had been transformed into a Jesuit mission by the end of the 17th Century (CRHP 2022). By 1716, the French had established a mission at Meductic, and the first church on the St. John River was constructed adjacent to the burial ground (Raymond 1897). A school was established at Meductic in 1788 (Raymond 1897). The remains of this school, along with an earlier trading post, were uncovered during salvage excavations funded by the New Brunswick Electric Power Commission in the 1960s (Caywood 1969). Excavations conducted near the burial ground at Meductic in 1964 by Dr. George Frederick Clarke (Clarke 1970) uncovered a large stone fireplace, hand-wrought nails, broken glass, and numerous metal artifacts, which may be the remains of either the church or the residence of the priest. By the 20th century, the church was no longer standing, and its exact location was unknown at the time of the creation of the headpond (McIntosh n.d.).

Literature suggests that the headpond area would likely have been a stopping place between Québec and the French outposts located along the St. John River at and downstream of what is now Fredericton (McIntosh n.d.). No evidence exists to indicate there was any permanent French or Acadian settlement or buildings in the headpond area except for Meductic (McIntosh n.d.). Following the expulsion of the Acadians in 1755, most, if not all, of the Acadian settlements along the St. John River were destroyed by 1758 (Gordon and Grant 1975). Some Acadians fled to Maugerville, and later to what is now Keswick Ridge (“The French Location”). Traces of former Acadian presence exist in the form of place names and family names in areas such as Keswick Ridge (Gordon and Grant 1975); however, there does not appear to be documentation demonstrating physical evidence of settlement in the headpond area.

Planters (post-1755)

Following the expulsion of the Acadians in 1755, there was a strong desire to have people loyal to the British settle in these now “unoccupied” lands. Many of these people settled in what is now known as the city of Saint John and surrounding areas. The so-called Planters established trading posts and fishing stations in what is now Saint John. They brought farming experience from the New England colonies and had knowledge of other industry such as milling (Gordon and Grant 1975). However, it is not believed, or at least not documented, that any of these Planter families established homesteads upstream of the Maugerville area (McIntosh n.d.).

Loyalist Period (1783-1860)

Following the end of the American Revolution in 1783, large tracts of land were made available in Nova Scotia (which at the time included the province now known as New Brunswick) to those forced to leave the United States because of their loyalty to the British Crown. This period marks the first time since the arrival of Europeans to New Brunswick that a concerted effort was made by European-derived peoples to settle the lands within or near the area now known as the Mactaquac headpond. A considerable number of settlers, Loyalists, as well as others of European descent, established themselves up and down the St. John River valley during this time. They occupied land that is currently beneath the headpond and up to Woodstock, although it appears that no land grants were officially issued for the lands west of Keswick Ridge until 1799 (Gordon and Grant 1975).

By 1783, approximately 1,300 Loyalists had arrived in the St. John River valley. Within one year, the number had risen to 9,260 (Gordon and Grant 1975). Most of these settlers were farmers and working in forestry activities. Woodstock, New Brunswick's first town, was established by Loyalist settlers in 1786.

One example of Loyalist settlement from this early period occurring in the headpond area was at Bear Island, which was settled by two Loyalist regiments in 1787 (Trail 2002). Though Bear Island itself is now submerged under the headpond, the community was on the shoreline of the St. John River and not on Bear Island or any of the other six small islands at this location within the river, presumably because these islands flooded annually during the spring freshet.

Two sons of a Planter family from Maugerville, Daniel and Thomas Jewett, moved up-river to Keswick in 1802 on land grants that were applied for previously by Daniel Jewett Senior (Gordon and Grant 1975). There, Daniel and Thomas established themselves at the confluence of the St. John and Keswick Rivers. The two brothers relocated to Keswick Ridge in 1802, and soon crossed over Keswick Ridge to the west bank of Mactaquac Stream (now the Mactaquac Arm) (Gordon and Grant 1972). Here, Daniel Jewett built a dam to provide waterpower prior to constructing a log house, rock and timber dam, a sawmill, and grist mill. By 1858, the growing Jewett family built a new home of timber frame construction using wood from their own mill. The community prospered further as the third house was built (later called the Ingraham House). The sawmill and grist mill were still operational throughout the growth of the community (Gordon and Grant 1972).

A house built by one of Daniel Jewett's sons, Enoch, was located across the Mactaquac Stream. The house was still standing at the time of the headpond flooding and was relocated on the new road leading from what is now Mactaquac Park to Scotch Settlement (Gordon and Grant 1972). Most of the descendants of these families remained living on the Mactaquac Stream until the construction of the MQGS.

Gordon and Grant (1972) refer to an early "negro settlement," including a small church that existed between the old St. John River Road and Jewett's Mills. These may have been Black Loyalists who migrated north during the American Revolution (Library and Archives Canada 2012). A Black Loyalist cemetery located in Keswick Ridge, approximately 1 km north of the PDA, is a registered archaeological site, BlDr-5 (Nicholas, M., pers. comm., 2015, in Stantec 2016). Gordon and Grant also refer to an Indigenous encampment located about 1 km from Daniel Jewett's first home in Jewett's Mills.

Few roads were established during this time because travel was conducted primarily by water (Rees 2012). There was little need for long-distance travelling outside of the St. John River. Due to the importance of the river as a transportation system, there were many boat landings, local access roads, and wharves built to accommodate this type of transportation along the river in what is now the headpond.

Colonial Period to Construction of MQGS (ca. 1860 – 1967)

Settlement and occupation in the area now covered by the headpond was continuous from the Loyalist Period until the construction of the MQGS and continues today upland of the current shorelines of the headpond. By 1845–1846, the first steamer, the Carleton, was making regular trips on the St. John River between Fredericton and Woodstock (Gordon and Grant 1975; McIntosh n.d.) until operations were discontinued due to competition from the Canadian National Railway in 1906 (Trail 2002). According to McIntosh (n.d.), the most notable centres for settlement during and after the Loyalist period were at Prince William, Dumfries, Pokiok, Queensbury, Southampton, Meductic, and Woodstock.

By 1866, Bear Island was an established farming community inhabited by 86 families. The population had reached 250 people by 1871 (Trail 2002). Bear Island Congregational Church was erected in 1872 and was demolished with the construction of the MQGS. A new church was built at the beginning of Scotch Lake Road in 1968 (Trail 2002).

Houses in the St. John River valley that were constructed out of logs, with chimneys and fireplaces constructed from stones embedded in clay, were being replaced by homes constructed of stone or frame houses, built from timber provided by nearby mills (*e.g.*, Jewett's Mills), with brick chimneys (Gordon and Grant 1975). Many of the homes included cellars dug up to at least four feet deep to prevent damage to the foundations from the cold winters and provide for cool storage areas for the harvest (Trail 2002).

Farms and other operations remained active in the area now occupied by the headpond until the decision to construct the MQGS in the 1960s when the provincial government encouraged (and eventually forced) those living in the portion of the river valley that was to be flooded to leave the area. Progress reports leading up to the construction of the MQGS (Resource Development Engineering 1966) indicated that 340 buildings (not including churches and schools) were located within the flood zone needed for the headpond. Some homes were moved to other locations above what would become the high-water mark of the current headpond. Some of the more prominent or historic homes and structures were moved to the newly established tourism village, Kings Landing, in an attempt to preserve them and to provide some compensation for flooding of the land through increased tourism potential for the area. Other buildings were either demolished or burned so that there were virtually no standing buildings within the headpond at the time of flooding, with the exception an NB Tel building constructed out of stone (Myles, D., pers. comm., 2015, in Stantec 2016). All bridges within the area now covered by the headpond were demolished, but some remnants remain today, either submerged or visible on the banks of the headpond.

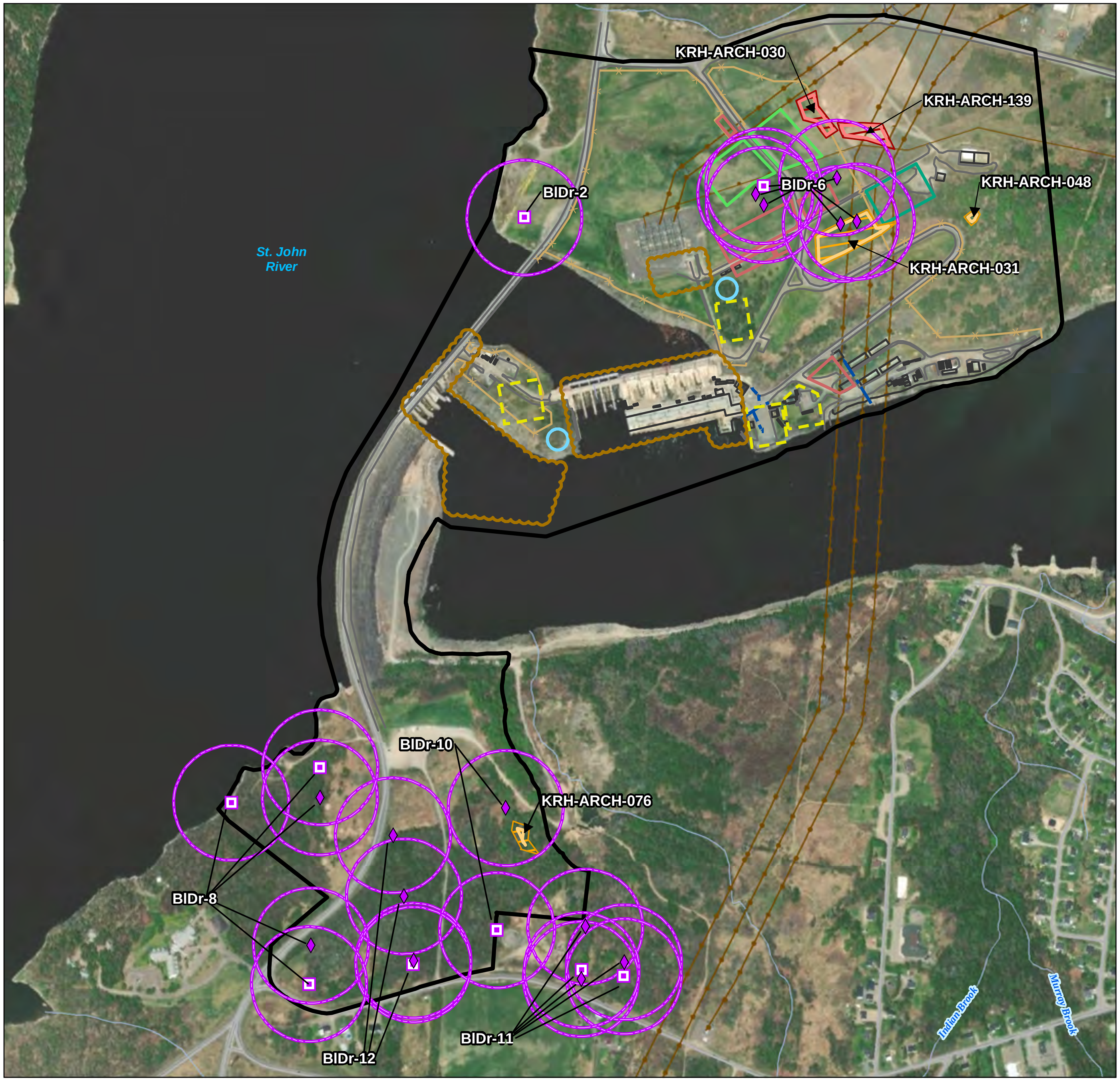
The flooding of the land following the construction of the MQGS resulted in the widening of the St. John River and its tributaries including Kelly Brook (now Kellys Creek) and Longs Creek, creating lake-like conditions in the river. The flooding resulted in the loss of islands including Snowshoe, Wheeler, Great Bear, and Long Islands, and portions of the old TransCanada Highway No. 2, as well as the abandonment of a portion of the Canadian National Railway (H.G. Acres and Company Ltd. 1969). Some of this now submerged infrastructure remains discernible to this day by careful observation of bathymetric records collected by the Canadian Rivers Institute in support of the Mactaquac Project (Stantec 2016).

Registered Historic Archaeological Sites

During the Comparative Environmental Review (CER) for the refurbishment of the Mactaquac Dam Project, the archaeological assessment of the lands around the dam conducted by Stantec in 2016 identified several known and unknown Historic Period archaeological features. The previously unknown features were registered as archaeological sites with the Province of New Brunswick following the completion of the 2016 assessment (Stantec 2016). Of the nine registered Historic Period archaeological sites and two historic cemeteries identified during that assessment within or near the boundary of PID 7528699, a total of five Historic Period sites are currently located inside the PDA, none of which are cemeteries. A sixth registered site is located close enough to the PDA that its regulatory 100-m buffer zone interacts with the PDA. Of the five registered sites within the PDA, two are located on the property north of the dam (BlDr-2 and BlDr-6) and three are located on the property south of the dam (BlDr-8, BlDr-10, and BlDr-12) as well as the sixth site whose buffer zone interacts with the PDA (BlDr-11) (Figure 11.1).

Registered site, BlDr-2, is a Historic Period site within the PDA located just above the dam on the north shore of the St. John River approximately 250 m west of the switching substation (Figure 11.1). Nicknamed “The Trench Site”, it was first identified in 1976 during surface collection of historic period ceramics from a trench that was excavated on the ridge overlooking the Mactaquac dam. It consists of an occupation, but no other detailed information is available. This site and its 100-m regulatory buffer zone could interact with a potential water access point for the Project. According to the provincial Archaeological Potential Mapping, this area is also located on a potential palaeo-shoreline which carries elevated potential for pre-contact archaeological resources.

BlDr-6 is a registered Historic Period homestead within the PDA located approximately 200 m north-northeast of the switching substation. While the area is grassed over now, depressions likely from former building locations, are visible on the surface and likely represent the home, barn, and various outbuildings on the property. These features, at present, could interact with the proposed parking areas, and waste material storage and recycling areas for the Project (Figure 11.1). The land was granted to Abraham Close in the late 18th or early 19th century, likely a Loyalist settler (PANB 2016a and 2016b). Features of the homestead are visible on the 1950s and 1960s aerial imagery of the area and were likely torn down during the construction of the Mactaquac dam (NBDNR 1951).



Stantec

- Project Development Area

Heritage Features

- Registered Archaeological Site
- Related Site Feature
- AHB Site Buffer (100 m)

Archaeological Potential Areas

- High Potential
- Medium Potential

- Construction Area
- Waste Material Storage and Recycling
- Laydown Area
- Temporary Office
- Gate House
- Parking
- Potable Water Well
- Existing Building
- Fence
- Road Edge
- Storm Drain
- Road
- Transmission Line
- Watercourse (DNR)

N

0 100 200 metres

(At original document size of 8.5x11)
1:10,500

Notes

1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan,

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 11/24/2022

Client/Project
121415886_0012
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessment

Figure No.
11.1

Title
Heritage Resources Within PDA

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An internal NB Power map showing the pre-MQGS landowner and building distribution (NBEPC 1964–1965) lists the property owners in the area as “The Director Veterans Land Act C.M.G. Arthurs” and the “Mactaquac United Baptist Church” as well as possibly “Mrs. Helen Hatfield” and “James Bedell”. This suggests that C.M.G. Arthurs, although the landowner in title at the time of the construction of the MQGS, may have acquired the land as late as post-Second World War, as the Veterans Land Act was passed in 1942 to provide loans and funds for soldiers returning from war to purchase land, livestock, equipment and even construct homes (Wright 2006). Six buildings are located on the NBEPC (1964–1965) map northwest of former Highway No. 21, now an access road within MQGS grounds, that eventually became the present-day Highway 105 further north. At least two other buildings are located southeast of this former highway.

Registered site BlDr-8 is a Historic Period site within the PDA located on the south side of the dam on the west side of the PDA and extends from the present-day headpond shoreline to the east by approximately 350 m and is bisected by Mactaquac Road (Figure 11.1). The site comprises three features including a sub-rectangular stone pile and two linear stone features all of which are the remnants of a former farmstead visible in historic aerial imagery (NBDNR 1951). The land was granted to Hartman Freeland and Isaac Mills who were sub-grantees to George Lee in Kingclear Parish, and are among the 70 persons named on that same grant (PANB 2016a and 2016b). An internal NB Power map showing the pre-MQGS landowner and building distribution (NBEPC 1964–1965) lists the property owner at BlDr-8 as “Frank Kilburn”. The property extends from the present-day Highway 102, northwest to the right-of-way for the former railway. The historic aerial imagery (NBDNR 1951) shows these property boundaries / stone piles, alongside others located in the middle of the pasture, likely extended up to 170 m northwest and may now be under the headpond water.

BlDr-10 is a registered Historic Period site within the PDA comprising one long linear stone feature that extends over 200 m northwestward starting from near the French Village Road (Figure 11.1). It is likely a remnant of a property boundary or field boundary for a former farmstead visible in historic aerial imagery (NBDNR 1951). Review of the 1951 aerial imagery shows the buildings associated with this farmstead located 50 m west of this feature but no evidence for these buildings was visible on the ground’s surface during the 2016 AIA. Based on available information for the property, the land was granted to Jeremiah Prosser in 1799 (PANB 2016a). Prosser was a sub-grantee to George Lee in Kingsclear Parish and is among the 70 persons named on the same grant (PANB 2016b). An internal NB Power map showing the pre-MQGS landowner and building distribution (NBEPC 1964–1965) lists the property owner as “Randolph Kilburn” and the property extends from the present-day French Village Road northwest to the right-of-way for the former railway.

Registered site BlDr-12 is a Historic Period site within the PDA that begins from near French Village Road and extends northwestward toward a parking lot / lookout overlooking the main dam and diversion sluiceway (Figure 11.1). The site is comprised of three stone pile features, including one large and elongated stone pile, one made up of three smaller piles, and one located along a property boundary. The elongated stone pile and the one made up of three smaller piles are visible in historic aerial imagery of the farmstead on the property (NBDNR 1951). An internal NB Power map showing the pre-MQGS landowner and building distribution (NBEPC 1964–1965) lists the property owner as “Douglas Kilburn”. The property extends from the present-day French Village Road northwest to the third stone pile located near a property boundary visible in the 1951 aerial imagery. The surrounding property to the north and east is listed as "Randolph Kilburn" (associated with BlDr-10) and to the west, "Frank Kilburn" (associated with BlDr-8). The 1951 aerial imagery reveals a house visible on this property approximately 110 m west of the southern-most elongated stone pile feature. No evidence of these features was visible on the ground's surface during the AIA in 2016.

BlDr-11 is a registered Historic Period site that is located outside of the PDA; however, its 100-m wide regulatory buffer zone interacts to some extent with the PDA (Figure 11.1). It is located near French Village Road, east of a present-day parking lot where a former NBDTI sand hopper was located. The site comprises two parallel linear stone features on a northwest-southeast axis, one measuring 92 m and the other 24 m. The features are likely remnants of a property or field boundary for a former farmstead visible in historic aerial imagery (NBDNR 1951). Based on available information for the property, the land was granted to George Lee in 1799 in Kingsclear Parish, with 70 other persons named on the same grant (PANB 2016a and 2016b). An internal NB Power map showing the pre-MQGS landowner and building distribution (NBEPC 1964–1965) lists the property owner as "Annie M. Gray" and the property extends from the present-day French Village Road northwest to the right-of-way for the former railway. There are no visible structures on this property on either the NBEPC map or the historic aerial photography, nor were any features identified in the field as possible domestic structures.

Archaeological Impact Assessments Conducted within the PDA

In recent years, two Archaeological Impact Assessments (AIA) were conducted within the PDA. The first occurred during the environmental review for the refurbishment of the Mactaquac Dam Project (Stantec 2016) and the second occurred as part of the 138 kV Reliability for Fredericton South Project (Stantec 2020). Within the PDA, the assessment in 2016 identified five areas that exhibited elevated potential for sub-surface archaeological resources: four polygon areas on the north side of the PDA and one polygon area on the south side of the PDA. Recommendations for additional mitigation (*i.e.*, shovel testing) were made for these five areas. These five areas were delineated by Polygons KRH-ARCH-030, KRH-ARCH-031, KRH-ARCH-076, KRH-ARCH-139, and KRH-ARCH-148 (Figure 11.1). That assessment also identified several surface-visible features that led to the registration of Historic Period sites BlDr-6, -8, -10, -11, and –12 discussed above.

The second assessment in 2018-2019 confirmed the presence of surface-visible features associated with BlDr-6 and included a shovel testing program that saw 56 archaeological test pits excavated within the 100 m buffer zone for BlDr-6, approximately 40 m west of its surface-visible features. During the shovel testing program, new details emerged about the history of the PDA. Archaeologists conducting the testing program were presented by NB Power with internal large format aerial imagery that revealed how the PDA had been previously used as the living quarters for all those who worked on the construction of the dam between 1965 and 1968. The living quarters were visible in the imagery as large H-frame accommodation complexes spread across the PDA during these years. Also visible in the imagery were the buildings associated with the BlDr-6 homestead which appear to have also been occupied and used by the dam builders. It is assumed therefore that the Historic Period homestead was torn down and removed at the same time as the dam builder's living quarters. Of the 56 test pits excavated within the PDA, nine were positive for cultural material comprised of some possible Early Post-Confederation artifacts mixed with predominantly modern cultural material. The material recovered was comprised of possible stone footings (disarticulated/disturbed), undetermined metallic objects, nails, clear flat glass, red brick, fashioned wood, electrical wiring, and frequent charcoal. This material was interpreted as reflecting two distinct occupations: the first associated with the Historic Period homestead and the second associated with the dam builder's living quarters from 1965 to 1968 (Stantec 2020).

11.3.2.3 Palaeontological Resources

During the environmental review for the refurbishment of the Mactaquac dam project, a Palaeontological Report (Miller 2015) was commissioned based on known data sources within the PDA. The report states there are no known fossil localities immediately surrounding the MQGS in the area of the PDA. Miller (2015) does note, however, that previous reports indicate several graptolite fossil localities near the MQGS. According to a sketch map that was provided prior to the construction of the MQGS, one fossil location may on the south bank of the St. John River, outside the current PDA; however, the precise location is unclear on the sketch maps. Other graptolite fossils were collected in the late 19th or early 20th century and were given the names of Murray Brook and Murray's Creek, likely associated with the Burtts Corner Formation near French Village (Miller 2015). Graptolite fossils are considered important because they are used for dating and correlation of rocks and are not common fossils in New Brunswick (Miller 2015).

The PDA is in a relatively uniform geological setting with very few features located within the PDA. The bedrock base is characterized by Silurian-aged Kingsclear Group, Burtts Corner formation, which includes light grey, medium- to coarse-grained wacke, noncalcareous siltstone and shale (St. Peter and Fyffe 2005). The surficial geology of the PDA and surrounding area is characterized by a lag deposit of sandy or stony till veneer diamicton (sediments originating during Pleistocene glaciation) occurring in patches over rock and reworked by glaciolacustrine or glaciomarine processes. Overall, these geological conditions have the potential to contain fossils. It is possible, therefore, where bedrock is encountered that interactions could occur between Project activities and fossil resources.

11.3.2.4 Built Heritage

A search of the Canadian Register of Historic Places (CRHP 2022) and the New Brunswick Register of Historic Places (NBRHP 2022) found that there are no registered historic places or heritage sites located within or near the PDA. No buildings of heritage value were found during the AIAs (Stantec 2016; 2020).

11.4 EFFECTS ASSESSMENT

11.4.1 Assessment Criteria

11.4.1.1 Residual Effects Characterization

Table 11.1 presents definitions for the characterization of residual environmental effects on Heritage Resources. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not possible.

Table 11.1 Characterization of Residual Effects on Heritage Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** - an effect that moves measurable parameters in a direction beneficial to heritage resources relative to baseline. **Adverse**— an effect that moves measurable parameters in a direction detrimental to heritage resources relative to baseline.
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible**—no measurable change to heritage resources. **Low to Moderate**—if heritage resources are encountered within the PDA and cannot be avoided, mitigation (*e.g.*, removal) will create a change to heritage resources. **High** – a measurable change resulting in a permanent loss of information relating to heritage resources (*e.g.*, destruction that occurs without mitigation).
Geographic Extent	The geographic area in which a residual effect occurs	**PDA/LAA –** residual effects are restricted to the PDA/LAA
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short-term** – the residual effect is restricted to the construction phase. **Long-term** – the residual effect will extend for the life of the Project. **Permanent** - heritage resources cannot be returned to their existing condition.
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not applicable** – timing does not affect the VC **Applicable** – time affects the VC

Table 11.1 Characterization of Residual Effects on Heritage Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** – an effect on heritage resources occurs only once (*i.e.*, disturbance results in the loss of context). **Multiple irregular event –** the residual effect occurs at no set schedule **Multiple regular event –** the residual effect occurs at regular intervals **Continuous –** the residual effect occurs continuously
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – the effect is likely to be reversed **Irreversible**—the effect cannot be reversed as damage or removal will result in a change to Heritage Resources.
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

11.4.1.2 Significance Definition

A significant adverse residual environmental effect on heritage resources is defined as one that:

- Results in a non-permitted contravention of the *Heritage Conservation Act* (2010), or
- Threatens the long-term persistence or viability of a heritage resource or the information and context relating to it in the PDA, including effects that are contrary to or inconsistent with the goals, objectives, or activities of Indigenous communities, the general public, and provincial or federal management strategies

11.4.2 Potential Project Interactions with Heritage Resources

Undocumented heritage resources, where present, are typically located in the upper soil or rock layers of the earth and therefore potential interactions between these resources (particularly archaeological resources and palaeontological resources, if they are present) and the Project would take place during construction. Construction activities that could result in a potential interaction with heritage resources include site preparation (*e.g.*, clearing, grubbing, detouring and ditching, excavation and blasting, if required), temporary facilities, and construction of Project components. Groundbreaking, earth moving, and in-filling activities will be limited to areas of the PDA where major construction components and activities are anticipated. These activities will largely be carried out by mechanical means and can interact with heritage resources as these activities may result in some ground disturbance. Specifically, ground disturbance could interact with registered archaeological sites within the PDA or unknown sub-surface archaeological and palaeontological resources, if present, within the PDA. With no built heritage resources identified inside or near the PDA, interactions between Project construction activities and built heritage resources are not anticipated. Therefore, built heritage resources will not be assessed further in this VC. Any equipment that may need to be installed will take place after foundations and other surface and subsurface infrastructure are installed and will not interact with heritage resources.

In consideration of these potential interactions, the assessment of Project-related environmental effects on heritage resources is therefore focused on the potential environmental effects listed in Table 11.2. These potential environmental effects will be assessed in consideration of specific measurable parameters, also listed in Table 11.2.

Table 11.2 Potential Environmental Effects and Measurable Parameters for Heritage Resources

Potential Environmental Effect	Effect Pathway	Measurable Parameter
Change in heritage resources	• Disturbance or alteration of whole or part of a heritage resource from Project ground disturbance during construction	• Presence/absence of heritage resource

Table 11.3 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 11.3 Potential Interactions Between Physical Activities and Heritage Resources

Physical Activities	Potential Interaction between Physical Activities and Heritage Resources
Construction	
Site preparation	✓
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	-
Insolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	-
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	-
Shut down of power units	-
Fish passage	-
Transportation (*powerhouse: transportation of equipment)*	-
Employment and expenditure	-

Table 11.3 Potential Interactions Between Physical Activities and Heritage Resources

Physical Activities	Potential Interaction between Physical Activities and Heritage Resources
Operation and Maintenance	
Operation of the MQGS	-
Maintenance of the MQGS	-
Fish passage	-
Decommissioning	
Decommissioning of the MQGS	-
Site rehabilitation	-
Notes: ✓ = Potential interaction – = No interaction	

11.4.2.1 Potential Effects to Heritage Resources During Construction

The construction phase may result in the development of temporary, land-based ancillary facilities such as laydown areas, parking areas, potable water wells, waste material storage and recycling area, water access points, and temporary offices that could result in ground-breaking and earth moving activities and associated physical soil disturbance (*i.e.*, grubbing, grading, rutting, and bedrock blasting, if required) that could affect both identified and unidentified heritage resources. These initial phases of construction hold the most potential to have an adverse and irreversible interaction with archaeological and palaeontological resources if they are present in the construction footprint. Given that registered sites BlDr-2, -6, -8, -10, -11, and -12 interact with the PDA, the proponent will need to consult with AHB before initiating any planned groundbreaking activities within the 100 m buffer zones of these sites and may need to apply for a Site Alteration Permit (SAP) from AHB ahead these activities. Depending on the requirements of the SAP, additional mitigation may be required before construction activities can begin.

Most of the areas identified for construction contain large amounts of bedrock. This bedrock could contain fossils on its surface that would be exposed and/or altered should any blasting activities associated with the removal of this material take place to make way for the new facilities. While there are no fossil reports on record within 500 m of the current MQGS, it is possible that some of the bedrock to be affected by construction may contain graptolite fossils. There are reports of fossil locations near MQGS, but exact locations are not known (Miller 2015). Activities listed under construction that are not anticipated to interact with heritage resources include in-water work, work above water line, shut down of power units, transportation, and employment and expenditure, as they will not involve ground-breaking activities. Clean-up and/or revegetation may involve back blading but will occur within the existing previously disturbed construction footprint; therefore, additional, new ground disturbance is not anticipated in these areas.

11.4.2.2 Potential Effects to Heritage Resources During Operation and Maintenance

As noted in Table 11.3, there are no physical activities associated with the operation and maintenance of the Project that are anticipated to interact with heritage resources. Therefore, as environmental effects to heritage resources are not anticipated to occur during Operation and Maintenance activities, they will not be considered further in this assessment.

11.4.3 Mitigation for Heritage Resources

The following mitigation measures specific to heritage resources are recommended for the Project.

- Planned avoidance, where practical, of registered sites BlDr-2, -6, -8, -10, -11, and -12 and their 100 m buffer zones as well as areas identified during the AIAs that exhibit elevated potential for heritage resources (*i.e.*, field-delineated polygons from the 2016 AIA)
- If avoidance of the registered sites and their 100 m buffer zones and/or areas of elevated archaeological potential is not possible, it is recommended that NB Power consult with AHB regarding the need for additional mitigation (*e.g.*, shovel testing, archaeological excavation, or archaeological monitoring) or the need for a Site Alteration Permit (SAP) for any planned construction activities that may interact with the sites themselves or their respective buffer zones.
- To mitigate for the unplanned discovery of a potential heritage resource (including archaeological and palaeontological resources) during all phases of the Project, a Heritage Resource Discovery Response Plan is to be developed and included in the Project Environmental Protection Plan. The Heritage Resource Discovery Response Plan would be implemented if heritage resources (*e.g.*, artifacts or fossils) are discovered during construction.
- As required by the Heritage Conservation Act, the discovery of a heritage resource must be reported to AHB.

11.4.4 Characterization for Residual Project Environmental Interactions for Heritage Resources

11.4.4.1 Residual Effects on Heritage Resources during Construction

Potential pathways for interactions with heritage resources are related to direct ground disturbance resulting from site preparation and construction activities planned within the PDA. An AIA conducted for the PDA identified several archaeological sites within the PDA that have now been registered with AHB, as well as areas of elevated archaeological potential. The remainder of the PDA has been considered to be generally of low archaeological potential. The interaction with heritage resources during construction would be adverse in direction and low to moderate magnitude as the disturbance of a heritage resource may result in the loss of information and the ability to implement mitigation following the identification of a heritage resource. The geographic extent is limited to the PDA, the area of physical disturbance during this phase of the Project where heritage resources are located and thus the implementation of mitigation is achievable. Within the PDA, the potential interaction would be limited to those areas where pre-construction mitigation was not implemented. Timing of the effect is not applicable since heritage resources are relatively permanent features of the environment, and frequency of the effect would be a single event as the disturbance of a heritage resource can only be adversely affected once. Duration of the effect is permanent, and the effect would be irreversible as the disturbance of heritage resources may result in the permanent loss of some information and context relating to the heritage resource. The implementation of a heritage response protocol, however, would likely result in the rescue of most information. The ecological context of the PDA is disturbed/undisturbed for construction activities, since much of the area has been subject to agricultural and previous construction activities in the relatively recent past, but there remain some areas where pre-Project disturbance is minimal.

In the unlikely event that a heritage resource (*i.e.*, archaeological or palaeontological) is encountered, if it is damaged and determined by provincial agencies to be important, then the interaction would be adverse. However, with the implementation of the mitigation described above, this interaction is unlikely and, if it were to occur, would be further mitigated by the implementation of the Heritage Resource Discovery Response plan that will be included in the Environmental Protection Plan to be developed for the Project.

A summary of the residual environmental effects characterization (Table 11.1), following the application of mitigation measures described above, on heritage resources during the construction phase of the Project is provided in Table 11.4.

Table 11.4 Project Residual Effects on Heritage Resources

Residual Effect	Residual Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in heritage resources	C	A	L/M	PDA	LT	N/A	S	I	D/U
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

KEY:
See Table 11.1 for detailed definitions

Project Phase
C: Construction
O: Operation and maintenance

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

11.5 DETERMINATION OF SIGNIFICANCE

With the implementation of mitigation and environmental protection measures as described in this assessment including avoidance of known sites and areas of elevated archaeological potential where possible, and consultation with AHB and the Indigenous community, as appropriate, it is anticipated that the residual adverse environmental effects of the Project on heritage resources will not be significant. NB Power will also follow the Heritage Resources Discovery protocols in the Environmental Protection Plan to mitigate unexpected discoveries. If heritage resources are discovered during construction activities, a mitigation plan will be developed in consultation with NB Power, AHB, and Indigenous communities, as appropriate.

11.6 FOLLOW UP AND MONITORING

A dedicated follow-up and monitoring plan is not required for heritage resources to verify the environmental effects predictions of the assessment or to verify the effectiveness of mitigation. It is anticipated that all mitigation regarding heritage resources will be determined prior to construction activities (*e.g.*, shovel testing or excavation prior to construction, or archaeological monitoring during construction) and implemented, as warranted. There will also be a Heritage Resources Discovery Plan in the event that heritage resources are encountered during the initial, ground disturbing phases of construction.

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12.0 INDIGENOUS COMMUNITIES

12.1 BACKGROUND

Indigenous communities have been selected as a valued component (VC) in recognition of the constitutionally protected rights of Indigenous people, and in recognition of the current and historical use of land and resources as an integral part of their lives and culture.

It is important to note that the information presented in this section is purposely general. New Brunswick Power Corporation (NB Power) initiated an extensive Indigenous engagement process beginning in 2014, which is ongoing, and funded a Traditional Land and Resource Use Study that was prepared by Moccasin Flower Consulting Inc. The results of the Traditional Land and Resource Use study are confidential, but it has informed NB Power's Project planning and decision making. The information provided in this section is based on general knowledge of First Nations use and culture, supplemented by literature sources such as publicly available Traditional Land and Resource Use reports and Traditional Ecological Knowledge reports for the St. John River basin.

This section provides general information about possible traditional activities that may be carried out by Indigenous persons (as informed by general knowledge). This chapter does not presume or replace information that has been made available to NB Power in confidence or that may become available through further engagement with Indigenous communities.

Indigenous people have lived on the land now known as New Brunswick for at least 13,500 years, with the Wolastoqiyik (Wolastoqey) people generally concentrated along the St. John River (Wolastoq) and the Mi'gmaq people concentrated along New Brunswick coastlines and interior (THRIVE Consulting 2015). The following is a brief overview of the existing conditions of the Wolastoqey Indigenous people and communities within the portion of the St. John River valley that is now the Mactaquac headpond and land surrounding the Mactaquac Generating Station (MQGS). It focuses on a roughly 100-year period that includes the time prior to and after the construction of the MQGS.

In their own language, "Wolastoqiyik" means "the people of the beautiful and bountiful river". The Wolastoqey call the St. John River, the main river around which their territory is centered, the Wolastoq, meaning "the good river" (Rayburn 1975). The Wolastoqey people are known to be traditional hunters, fishers, trappers, and gatherers who are intrinsically and culturally connected to the St. John River. There are six Wolastoqey Indigenous communities located along or near the river (Figure 12.1). These include:

- Matawaskiye (Madawaska Maliseet First Nation)
- Neqotkuk (Tobique First Nation)
- Wotstak (Woodstock First Nation)
- Bilijk (Kingsclear First Nation)
- Sitansisk (St. Mary's First Nation)
- Welamukotuk (Oromocto First Nation)

Bilijk is the closest Indigenous community to Mactaquac, located adjacent to the MQGS. Sitansisk is located approximately 20 km downstream of the MQGS, and Madawaska, Neqotkuk, and Wotstak are located further upstream of the MQGS (Figure 12.1).

The traditional territory of the Wolastoqey Nation is thought to include the greater St. John River watershed as far north as the Gulf of St. Lawrence to Québec City, and through the state of Maine where it meets the Peskotomuhkati (Passamaquoddy) territory. It extends south to the Bay of Fundy, and west where it meets Mi'kmaq traditional territory. Currently, most Wolastoqey people live in what is now western New Brunswick, though there are some smaller Wolastoqey communities in Québec and Maine.

The documented history of the St. John River watershed and the surrounding Indigenous communities, published by THRIVE Consulting (2015), details the deep spiritual and cultural connection of the local Indigenous people to the land, the local resources, and the St. John River itself. The St. John River and is considered the heartland of Wolastoqey territory. Not only was the river essential to the culture of the Wolastoqiyik and important for fishing, but the adjacent lands were also highly valued since they provided resources to build essentials (*e.g.*, canoes, housing, tools, pottery), resources for ceremonial purposes, and the lands were used to hunt, trap, and gather (Perley 2005).

Literature sources report that the St. John River and surrounding land provided everything necessary for life for the Wolastoqey people. Different resources were used depending on the season. For example, in the spring, maple tree sap was collected in bark containers. Early Europeans noted that sap was used to quench thirst (Timmins *et al.* 1992). During late spring and early summer, fiddleheads were abundant and harvested along streams and on many islands within the St. John River for consumption and for selling at local markets (Maliseet Nation Conservation Council 2011). In a spoken history study, participants recounted participating in fiddlehead harvesting in the month of May (Perley and Blair 2003). Annual temporary camp sites associated with fiddlehead harvesting and the harvesting of other plants were established on some of the islands within the St. John River (Perley and Blair 2003).

In addition to fiddleheads, the Wolastoqey were known to gather plants within the St. John River valley for consumption and for medicinal and ceremonial purposes. Some of the plants that were harvested include calamus roots, wild onions, sweet grass, and rice (Maliseet Nation Conservation Council 2011) as well as hemlock bark (Perley and Blair 2003). In the summer, sweet grass was used in basket making, as were white ash and black ash. Large baskets were sold to farmers for gathering produce and fish, and for use as pack baskets and clothes baskets. Smaller and more ornate baskets were made for storing sewing supplies, combs, handkerchiefs, or were sold as decorative Easter baskets (Perley and Blair 2003). Baskets were often used for trading with local farmers and residents along the St. John River, but the Wolastoqey people also used them. In exchange for the baskets, farmers provided Wolastoqey people with goods such as eggs, potatoes, salt pork, beef, and produce. Accounts from the 1880s note that Indigenous peoples from Bilijk frequently visited the farms at Jewett's Mills to trade baskets for food items (Gordon and Grant 1972).

Literature explains that some of the tree species with the St. John River valley were used to make items related to transportation, including canoes, snowshoes, and toboggans, which were required for gathering resources and establishing trade networks. Cedar and birch trees were used commonly to build canoes. Maple, butternut, and ash wood were often used to make paddles. Boiled pine resin was made into pitch for sealing and mending canoes (Timmins et al. 1992). Black ash, white ash, and other tree species were used for furniture making, string, and axe handles. Alder, maple, willow, and birch bark were also used for furniture making.

After ice breakup on the St. John River, trap lines were set in various places near the MQGS, including the Mactaquac stream. Muskrat and mink were reportedly caught and used to make clothing. Other commonly trapped species include beaver, fox, otter, and weasel. Hunting along or near the St. John River occurred year-round. The Wolastoqey hunted several animal species, including deer, moose, and caribou (Perley and Blair 2003). Hunted animals were used for food, and various parts of the animals were used to make snowshoes, hats, gloves, and winter moccasins. Fishing was, and continues to be, very important to the Wolastoqey people.

Despite the substantial changes to Indigenous culture because of colonial settlement in the St. John River valley 400 years ago, Indigenous people continued to practice traditional practices in the 19^{th} and 20^{th} centuries. However, modern developments, including the construction and operation of the MQGS, further altered the culture of Indigenous communities in New Brunswick. There has been a decline in the availability of, and access to, land and resources, and changes to fish and wildlife populations.

With the creation of the headpond, the St. John River became a more lake-like environment above the MQGS, causing substantial changes to plant and animal populations. Many resources that were used for traditional purposes are no longer present, or not as abundant as they were prior to construction of MQGS. For example, many of the trees that currently grow along the headpond are upland species, such as pine and fir, rather than river valley species, such as ash.

Access to the land has been, and continues to be, altered by residential development along the shores of the headpond. Although some tree species that were traditionally used still grow in the area, many are located on privately-owned properties. Some of the land adjacent to these properties is Crown land or land retained by New Brunswick Power Corporation (NB Power); but Indigenous people are unlikely to seek resources close to these properties.

A participant in a traditional knowledge study noted that the creation of the headpond affected, and in some cases eliminated, several traditional plant species, such as sweet grass and sweet flag (Gagnon and Glynn 2009). Traditional plant gathering locations, such as the many small islands that were in what is now the headpond, are also no longer available; these islands were primary fiddlehead picking locations (Maliseet Nation Conservation Council 2011). Natural fish passage for species such as Atlantic salmon and striped bass was eliminated because of the presence of MQGS. Traditional fishing in the St. John River is a treaty right for Indigenous people; however, with declines in fish populations, many Indigenous people feel it is irresponsible to take that which is no longer in abundance.

It is important to note that this environmental impact assessment (EIA) registration document focuses on the MLAP, not the existence of the MQGS itself or the continued presence of the dam. The discussion that follows provides an overview of how the Project might interact with Indigenous communities, based on the reviewed literature, past project assessments/reports that were reviewed for relevant information, and the professional judgment of the study team.

12.2 POTENTIAL ENVIRONMENTAL EFFECTS

The Project will result in access limitations to lands and waters adjacent to the MQGS. Traditional activities or use of resources currently occurring in this area would be affected during Project construction. During the construction period, NB Power will communicate with the community of Bilijk and the broader Indigenous community to provide Project schedule information, specifically including any changes to access. During construction, access to the MQGS property will be controlled for safety and security, and as such access through the property for fishing by Indigenous people will not be available during this time but will likely resume following construction. Similarly, if traditional plants are being collected on the MQGS property, access will be limited during construction.

As discussed in Section 6, throughout construction, there will be emissions of dust and sound from the Project. Sounds emissions will particularly increase during pile driving for construction of cofferdams. These activities may result in occasional annoyance and nuisance effects to Bilijk. NB Power will limit activities that result in sound emission to daytime hours to the extent feasible to reduce nuisance noise.

As discussed in Sections 7, 8, and 10, substantive changes to plant, wildlife, and fish populations are not expected as a result of the Project, thus substantive changes in the availability of these resources are not anticipated.

NB Power is committed to providing meaningful opportunities for ongoing dialogue about the Project with Indigenous communities. Consultation and engagement that has occurred to date and will continue throughout the Project is described in Section 4. As Project planning and design continues and throughout the execution of the Project, NB Power is committed to ongoing consultation and engagement with Indigenous communities.

Over the remaining life of the MQGS, NB Power will consult and engage with Indigenous communities to identify opportunities for benefits and accommodation. A capacity funding agreement has been established between the Wolostoqey and NB Power. As part of that agreement, the Wolostogey and NB Power co-developed a process to develop accommodation if and as required to adverse effects that cannot be mitigated.

12.3 REFERENCES

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Rayburn, A. 1975. Geographical Place Names of New Brunswick. Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa, Ontario.

13.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON TRANSPORTATION

The potential Project-related effects on transportation are assessed in this section. The assessment is limited to road transportation, as no other modes of transportation (*e.g.*, rail, air, or water) will be affected by the Project.

13.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

Transportation refers to the quality of road transportation networks and infrastructure and their capacity to provide safe and efficient service for movement of vehicles on provincial highways.

Transportation was included as a valued component (VC) because the Project may cause changes to existing road transportation infrastructure and levels of service as a result of Project-related traffic.

13.2 SCOPE OF ASSESSMENT FOR TRANSPORTATION

13.2.1 Regulatory Context

Road transportation on provincial arterial and collector highways, associated transportation network infrastructure conditions, and traffic management is the responsibility of the New Brunswick Department of Transportation and Infrastructure (NBDTI) under the authority of the New Brunswick *Highway Act*. Enforcement of traffic rules (*e.g*., speed limits and seasonal weight restrictions) under the New Brunswick *Motor Vehicle Act* is conducted by the New Brunswick Department of Justice and Public Safety (NBDJPS).

From the New Brunswick *Motor Vehicle Act*, the following speed limits are enforced by NBDJPS in the province:

- 30 kilometres per hour (km/h) in school zones during the hours of 7:30 am to 4:00 pm
- 50 km/h in urban districts
- 80 km/h in other locations where the speed limit is not otherwise posted

NBDJPS may also place mass restrictions on roads seasonally or on a necessary basis. These weight restrictions will be communicated with motorists via posted signs.

13.2.2 Spatial Boundaries

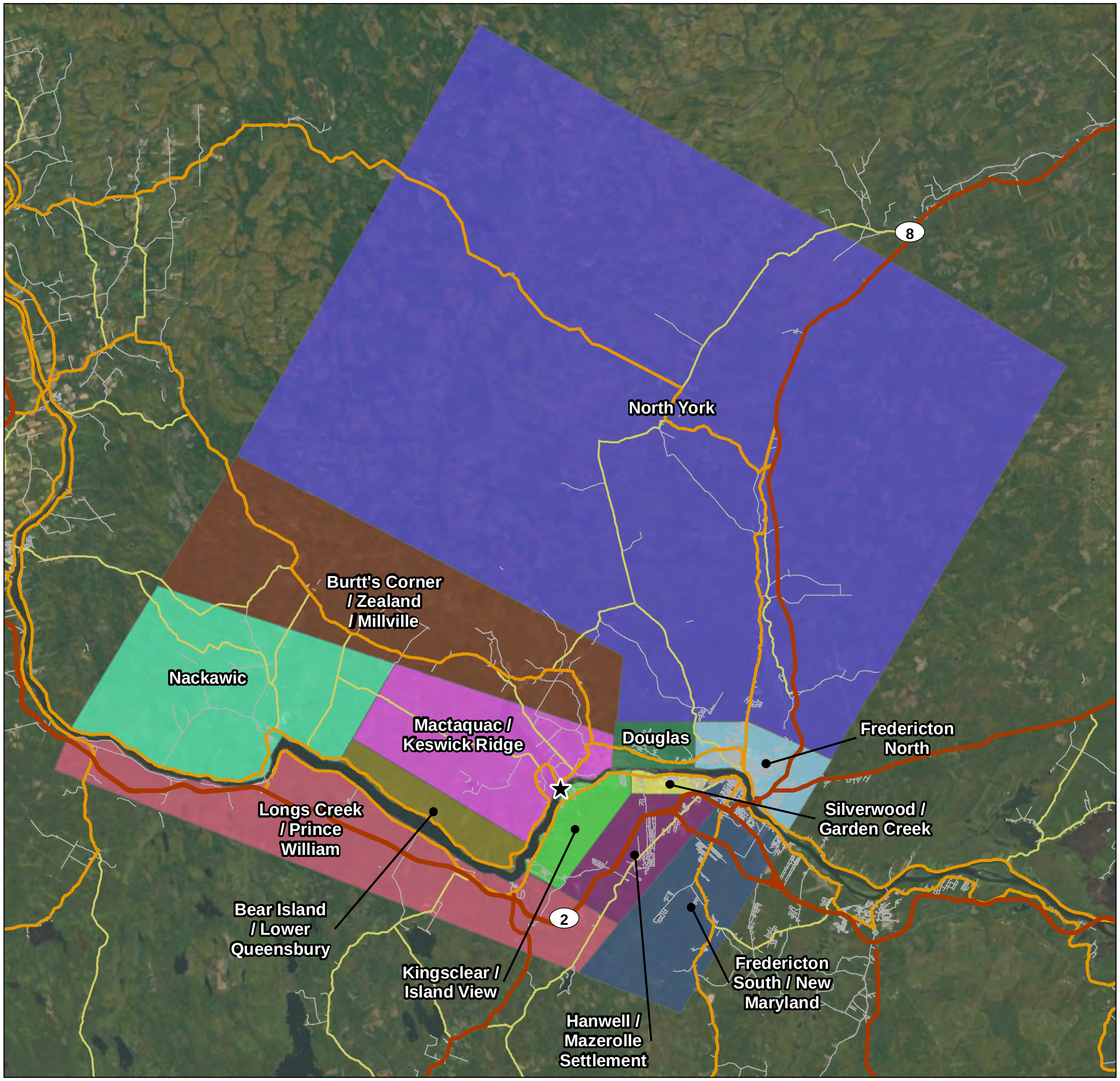
The assessment of potential environmental interactions between the Project and transportation is focused on a Project development area (PDA) and a local assessment area (LAA).

The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project. The PDA is depicted on Figure 2.1.

The LAA for transportation is defined as the area within which the environmental effects of the Project can be reliably measured or predicted, and can be thought of as the theoretical "zone of influence" of the Project on transportation. The LAA for transportation extends north approximately 88 km to the North York area, southeast approximately 26 km to New Maryland, and west approximately 48 km to the Nackawic area. This area is consistent with the study area for the traffic study conducted for the Project by exp (exp 2022) and includes the locations most likely to be affected by the Project.

The LAA for transportation is shown in Figure 13.1.

Figure 13.1 represents the LAA boundary zones surrounding the Mactaquac Generating Station (MQGS) which could be affected by Project-related transportation changes (exp 2022).



Stantec

Mactaquac Generating Station

Traffic Zone

- Bear Island / Lower Queensbury
- Burtt's Corner / Zealand / Millville
- Douglas
- Fredericton North
- Fredericton South / New Maryland
- Hanwell / Mazerolle Settlement
- Kingsclear / Island View
- Longs Creek / Prince William
- Mactaquac / Keswick Ridge
- Nackawic
- North York
- Silverwood / Garden Creek

- Arterial Highway
- Collector Highway
- Local Highway
- Other Road

N

0 6 12 Kilometres
(At original document size of 8.5x11)
1:600,000

Notes

1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2022-10-19

Client/Project 121415886_010
Coleson Power Group Inc.
Mactaquac Life Achievement Plan

Figure No.
13.1

Title
Spatial Boundaries for Transportation

\\ca0181-ppfss01\workgroup\1214\active\121415886\gis6_mapping\mxd\general\121415886_010_Transportation_Zones.mxd Revised: 2022-10-19 By: mblackwood

13.2.3 Temporal Boundaries

The temporal boundaries for the assessment of the potential Project-related effects on transportation include:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

It is important to note that repairs to the roadway and bridge planned by NBDTI to take place in 2023 are outside the scope of the Mactaquac Life Achievement Project (MLAP) and are therefore not included in the temporal boundaries.

13.3 EXISTING CONDITIONS FOR TRANSPORTATION

Existing conditions for the road transportation network that will provide access to the PDA are described in this section and include arterial, collector, and local highways. Bridges and interchanges in the LAA surrounding the Mactaquac area and extending from North York to New Maryland and Nackawic are also included. Mactaquac Road, one of the few road links in the region connecting the north side of the St. John River to the south side, is anticipated to be directly affected by Project-related activities and will be closed periodically during construction. The most recently available traffic counts for Mactaquac Road from 2018 indicated an Average Annual Daily Traffic (AADT) of 4,950 vehicles.

13.3.1 Approach and Methods

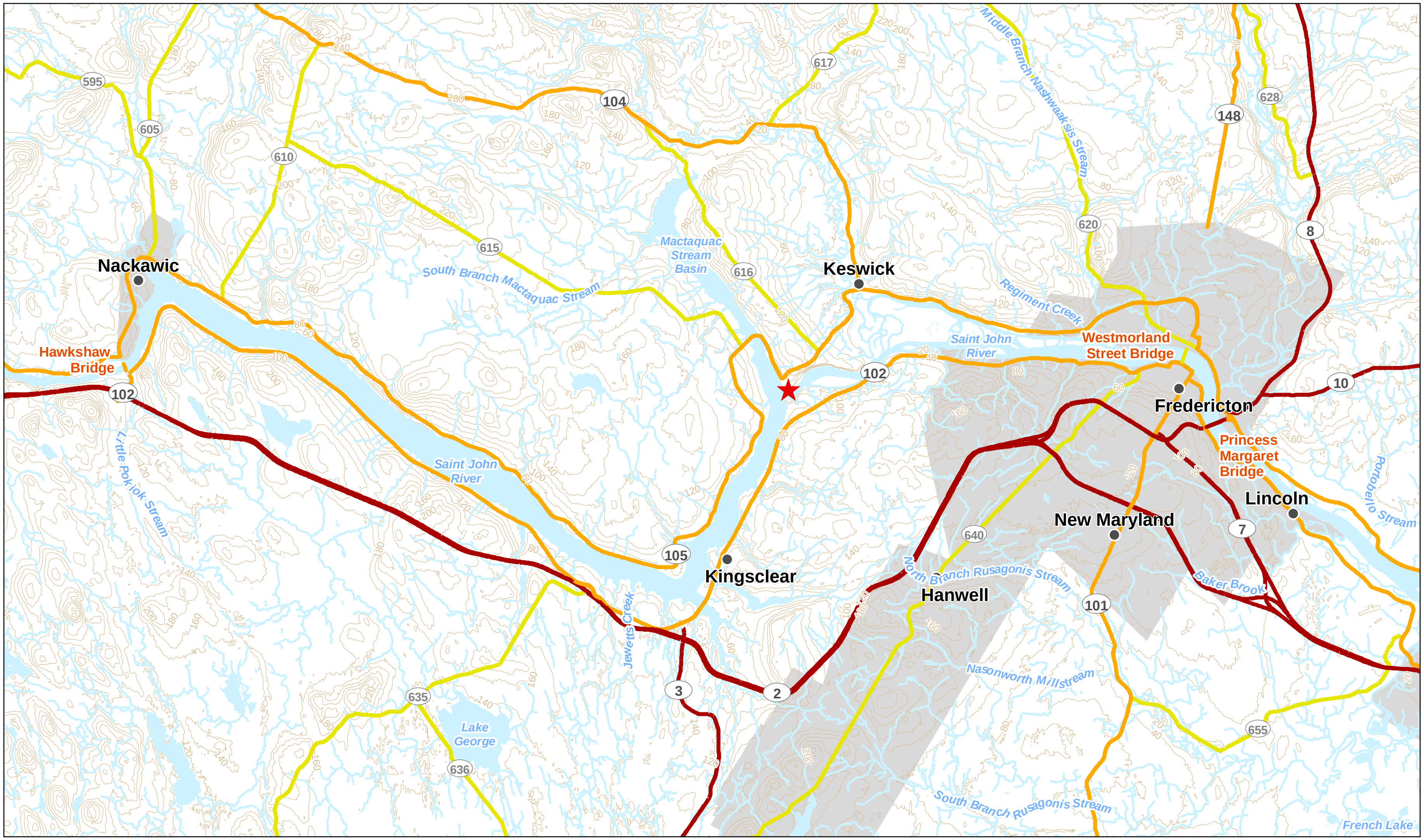
Transportation data was collected from available desktop sources where applicable, as well as from a traffic study completed by exp. Services Inc. in 2022. The exp. Services Inc. study used Streetlight Data's traffic database to generate traffic volumes and patterns.

13.3.2 Description of Existing Conditions

13.3.2.1 Transportation Network

Mactaquac Road crosses the St. John River (Wolastoq) and connects Routes 102 (south side) and Route 105 (north side). The road crosses the river on top of the MQGS rock-fill main dam and diversion sluiceway before crossing the left bank approach channel to the powerhouse via a 200 m bridge owned by NBDTI (exp 2015; Stantec 2016). This roadway has steady traffic volumes and is integral to the transportation of residents living in the surrounding communities (exp 2015). Partial lane closures at the diversion sluiceway on Mactaquac Road have been occurring annually throughout the summer months as crews conduct ongoing repairs to the sluiceway's bridge deck and substructure. Commuters who use this road have therefore experienced ongoing traffic disruptions seasonally, though Project-related closures will last longer than present closures and will result in full closure for periods throughout construction.

NBDTI is planning a project to carry out repairs to this roadway and bridge over the intake channel in 2023, which is outside the scope of this Project. Figure 13.2 provides an overview of the transportation network surrounding the MQGS.



Mactaquac Generating Station

Transportation Network

- Arterial Highway
- Collector Highway
- Local Highway

Contour (20m Intervals)

Municipal Area

Waterbody

N

0 3 6 Kilometres

(At original document size of 8.5x11)
1:260,000

Notes

1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c)

Stantec

Project Location
Mactaquac Generating Station
York County, NB

Prepared on 2022-10-18

Client/Project
NB Power
Mactaquac Life Achievement Project EA

121415886_009

Figure No.
13.2

Title
Transportation Network near the Mactaquac Generating Station

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Route 2 is a four-lane divided arterial highway that is part of the TransCanada Highway system. It provides a main route through New Brunswick and is the principal link between Fredericton, Nackawic, and Woodstock.

Route 3 is a two-lane undivided arterial highway. It begins at Route 2 south of Longs Creek and extends south towards St. Stephen, providing a link from the south of the province to Longs Creek, where drivers can travel to the Mactaquac area via Route 102.

There are three collector highways in the Mactaquac area, which are all two-lane undivided highways:

- Route 102 was part of the TransCanada Highway system and is locally referred to as the “Old TransCanada Highway”, originating at Pokiok (near Nackawic) and terminating at Grand Bay-Westfield, along the south side of the St. John River. It provides access from the south side of the MQGS and is the primary route used by travellers between the south side of Fredericton and Mactaquac.
- Route 104 links Hartland, Burtts Corner, and Keswick, and terminates at Route 105 at Keswick.
- Route 105 links Nackawic to Mactaquac and runs downstream of Fredericton, beginning at Grand Falls and terminating at Youngs Cove, along the north side of the St. John River. It provides access from the north side of the MQGS and is the primary route used by travellers between the north side of Fredericton and Mactaquac.

There are also six local highways in the general Mactaquac area:

- Route 605
- Route 610
- Route 615
- Route 616
- Route 620
- Route 635

There are four river crossings in the areas surrounding the MQGS:

- The Westmorland Street Bridge in Fredericton, which is the nearest river crossing downstream of the MQGS
- The Princess Margaret Bridge in Fredericton, which is located approximately 4 km downstream from the Westmorland Street Bridge
- The crossing across the MQGS, on Mactaquac Road
- The Hawkshaw Bridge in Nackawic, which is the closest crossing upstream of the MQGS

If Mactaquac Road is closed, traffic would detour to these or other crossings. The shortest detour route for the vast majority of traffic (*i.e.*, >95%) currently using Mactaquac Road would be the Westmorland Street Bridge. The two primary intersections along this route are:

- Route 105 (Ring Road) and Brookside Drive
- Route 105 (Ring Road) and Maple Street

An operational analysis was conducted for these two intersections to determine level of service (LOS) during daytime (AM) and nighttime (PM) peak hours, as shown in Table 13.1. LOS represents traffic operating conditions at intersections. Level of service is typically measured in seconds of delay experienced at major intersections and correlated to an LOS designation ranging from A (Excellent) to F (Unacceptable).

Table 13.1 Existing LOS at Primary Intersections

Intersection	AM Peak Hour LOS	PM Peak Hour LOS
Route 105 and Brookside Drive[1]	A	A
Route 105 and Maple Street	F	D

Note:
[1] The Route 105 and Brookside Drive intersection was recently upgraded to a roundabout, and this upgrade was considered in determining the existing LOS

As shown in Table 13.1, the Route 105 and Brookside Drive intersection is operating at an excellent LOS A. The Route 105 and Maple Street intersection is operating at an overall poor LOS F in the AM peak, and a satisfactory LOS D in the PM peak.

13.3.2.2 Mactaquac Road Traffic

Approximately 80% of daily trips on Mactaquac Road originate from, or are destined for, one of the 12 zones that make up the LAA surrounding MQGS shown in Figure 13.1. Most daily traffic generally travels between the Mactaquac area and Fredericton South area, with an AADT between these zones of 1,680 vehicles. The AADT of Mactaquac Road was found to be 4,950 vehicles.

13.4 EFFECTS ASSESSMENT

13.4.1 Assessment Criteria

13.4.1.1 Residual Effects Characterization

Table 13.2 presents definitions for the characterization of residual environmental effects on transportation. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not possible.

Table 13.2 Characterization of Residual Effects on Transportation

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves transportation in a beneficial direction **Adverse –** a residual effect that moves transportation in an adverse or detrimental direction
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible –** no measurable change from baseline conditions. **Low** - no damage to infrastructure and/or no change in overall LOS **Moderate –** slight increase or minor localized and/or repairable damage to road infrastructure, or unmitigated change in overall LOS by one category, but not below LOS D **High –** substantial damage to road infrastructure; substantial unmitigated change in overall LOS by more than one category or to lower than LOS D
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the PDA **LAA –** residual effects extend into the LAA
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term –** residual effect extends for less than 1 year **Medium term –** residual effect extends through the construction phase **Long term –** residual effect extends through the operation phase **Permanent –** recovery to baseline conditions unlikely
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not applicable –** timing does not affect the VC **Applicable –** timing affects the VC
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** **Multiple irregular event –** occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

13.4.1.2 Significance Definition

A significant adverse residual environmental effect on transportation is one where Project-related traffic:

- Results in a drop in the existing level of service of the road network below LOS D for roads and intersections that were otherwise classified as LOS A, B, or C, except for intermittent or short periods of time not exceeding one month, or
- Degrades road network infrastructure so that it cannot function at the current level of service and/or results in damage to the infrastructure that is substantive

13.4.2 Potential Project Interactions with Transportation

Activities and components have the potential to interact with transportation to result in adverse environmental effects. In consideration of these potential interactions, the assessment of Project-related environmental effects on transportation is therefore focused on the potential environmental effect listed in Table 13.3. This potential environmental effect will be assessed in consideration of a specific measurable parameter, also listed in Table 13.3.

Table 13.3 Potential Environmental Effects and Measurable Parameters for Transportation

Potential Environmental Effect	Effect Pathway	Measurable Parameter
Change in transportation	• Road closures and construction related traffic could result in a change to present transportation patterns or road infrastructure	• Travel time within the LAA • Level of Service • Quality of road infrastructure

Table 13.4 identifies the physical activities that may interact with transportation and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 13.4 Potential Interactions Between Physical Activities and Transportation

	Change in Transportation
Construction	
Site preparation	-
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	-
Isolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	-
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	-

Table 13.4 Potential Interactions Between Physical Activities and Transportation

	Change in Transportation
Shut down of power units	-
Fish passage	-
Transportation	✓[1]
Employment and expenditure	-
Operation and Maintenance	
Operation of the Facility	-
Maintenance of the facility	-
Fish passage	-

Notes:
✓ = Potential interaction
– = No interaction
[1] It is acknowledged that most Project-related activities during construction have the potential to either generate Project-related traffic and/or require temporary closures of Mactaquac Road, but for the purposes of this document, these have been combined into a single activity.

There will be no Project-related changes to transportation, traffic, or road closures during operation and maintenance of the MQGS following completion of the Project. Following construction, transportation is expected to return to baseline conditions.

13.4.2.1 Potential Effects to Transportation During Construction

Activities associated with the Project are expected to generate construction-related traffic at MQGS, along Mactaquac Road, and on the road network leading to it. These activities are likely to result in temporary or seasonal road or lane closures which may lead to driver inconvenience, a reduction in LOS, and increased travel times as a result of traffic diversions. Construction-related traffic will result in increased heavy truck movement and increased passenger vehicle movement generated by the influx of workers to the area. Traffic volumes related to the Project will occur over a long duration, as work will be completed over approximately 12 years.

There are likely to be short term or intermittent single lane and full closures and disruptions to traffic along Mactaquac Road during the Project. In addition, traffic delays on other parts of the road network as a result of increased Project-related traffic and diversions from closures are possible. When possible, full closure periods will be planned for off-peak hours and outside of tourist seasons; however, seasonal closures (potentially lasting several consecutive seasons) are likely to be required to enable the Project to be carried out, particularly when repairs to the diversion sluiceway bridge deck are being conducted. Partial lane closures at the diversion sluiceway on Mactaquac Road have been occurring annually throughout the summer months as crews conduct ongoing repairs to the sluiceway's bridge deck and substructure. Commuters who use this road have therefore experienced ongoing traffic disruptions seasonally, though Project-related closures may last longer than present closures and could result in full closure for periods throughout construction. During road closures, alternate routing through Fredericton or Nackawic will be required, and depending on trip origin and destination, may increase travel times for those traveling to use land and resources within the LAA. Traffic that diverts from the Mactaquac Road may cause delays as a result of increased volumes at other intersections in the LAA.

Project-related traffic will include trucks bringing construction materials and equipment to and from MQGS, as well as vehicles operated by Project workers.

13.4.2.2 Potential Effects to Transportation During Operation and Maintenance

As noted above, there will be no Project-related changes to transportation, traffic, or road closures during operation and maintenance of the MQGS following completion of the Project as compared to existing (baseline) transportation levels. Following construction, transportation is expected to return to baseline conditions. Therefore, there are no residual effects of the Project on transportation during operation and maintenance, and this phase is not discussed further in this chapter.

13.4.3 Mitigation for Transportation

The following mitigation measures specific to transportation have been identified for this Project.

As construction proceeds, NB Power will consider the following mitigation measures to reduce traffic volumes to site:

- Encouraging workers to carpool
- Providing shuttles from accommodation centres
- Establishing park-and-ride lots
- Staggering the start and end of shifts to spread traffic over a longer period

The transportation of personnel, equipment, materials, and services to and from the MQGS during the Project construction work could also damage existing road infrastructure from increased traffic volume or transport of heavy, oversized loads. NB Power will seek all necessary permits for extremely heavy or oversized loads from the Province, transportation routes will be planned, and the public will be notified (*e.g.,* by NB Power and NBDTI websites, social media, local newspapers, and radio advertisements) regarding long delays or disruptions to the transportation network.

During construction work for the Project, traffic control personnel and/or equipment (*e.g.,* lighted temporary signs, pylons, or temporary barriers) will be used, as necessary, to direct motorists within the transportation network and maintain traffic flows and safety. Traffic control will be implemented in accordance with NBDTI standards and policies.

Offsetting the peak hour of new traffic from typical morning and evening peak hours may be considered to help reduce traffic issues.

13.4.4 Characterization for Residual Project Environmental Interactions for Transportation

13.4.4.1 Residual Effects on Transportation During Construction

A temporary or extended closure of Mactaquac Road due to the Project would result in approximately 4,950 vehicles per day being detoured or foregoing their existing trip (exp 2022):

- Approximately 2,900 daily trips would be detoured for 10 minutes or more
- Approximately 870 daily trips would be detoured for 20 minutes or more

The majority of traffic is expected to detour via the Westmorland Street Bridge during a closure of Mactaquac Road (exp 2022). This would divert approximately an additional 4,100 vehicles per day to that bridge and detour route.

Two key intersections along this detour route are Route 105 (Ring Road) and Brookside Drive, and Route 105 (Ring Road) and Maple Street. The results of the operation analysis for these intersections are shown in Table 13.5, for AM and PM peak hours, with and without a closure of Mactaquac Road.

Table 13.5 Operation Analysis Results

Intersection	AM Peak		PM Peak	
	LOS Mactaquac Road Open	LOS Mactaquac Road Closure	LOS Mactaquac Road Open	LOS Mactaquac Road Closure
Route 105 and Brookside Drive[1]	A	A	A	B
Route 105 and Maple Street	F	F	D	D

Note:
[1] The Route 105 and Brookside Drive intersection was recently upgraded to a roundabout, and this upgrade was considered in determining the existing LOS

With a closure of Mactaquac Road, the Route 105 and Brookside Drive intersection is projected to operate at an overall excellent LOS A in the AM peak and very good LOS B in the PM peak. Operating conditions at the Route 105 and Maple Street intersection are expected to remain unchanged, with an overall poor LOS F in the AM peak, and a satisfactory LOS D in the PM peak.

The only traffic expected to detour via Hawkshaw Bridge would be that travelling between Mactaquac and Longs Creek. While the Princess Margaret Bridge in Fredericton provides an alternate detour route for vehicles travelling to Fredericton, it is not expected to be used by a substantial volume of detouring vehicles as the Westmorland Street Bridge is closer to Mactaquac than the Princess Margaret Bridge. Therefore, the Princess Margaret Bridge will not likely experience an increase in commuters due to Project-related traffic.

Project vehicles will comply with size and weight restrictions that may be applicable for existing roadways. If oversized vehicles are required, NB Power will work with NBDTI to obtain necessary permits and approvals, and will comply with any conditions of these approvals.

13.4.4.2 Residual Effects on Transportation During Operation and Maintenance

As noted above, there will be no Project-related changes to transportation during operation and maintenance. Following construction, transportation is expected to return to baseline conditions. Therefore, there are no residual effects of the Project on transportation during operation and maintenance, and this phase is not discussed further in this chapter.

13.4.4.3 Summary

A summary of the residual environmental effects on transportation during Project construction and operation and maintenance is provided in Table 13.6.

Table 13.6 Project Residual Effects on Transportation

Residual Effect		Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Timing	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in transportation	C	A	M	LAA	MT	NA	IR	R	D
	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

KEY
See Table 13.2 for detailed definitions

Project Phase:
C: Construction
O: Operation and maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

13.5 DETERMINATION OF SIGNIFICANCE

With the implementation of mitigation measures as described herein, the residual adverse environmental effects of the Project on transportation will be not result in a drop in the existing LOS of the road network below LOS D for roads and intersections that were otherwise classified as LOS A, B, or C, nor will they degrade or damage road network infrastructure such that it cannot function at the current level of service. Accordingly, the residual adverse environmental effects of the Project on transportation will be not significant.

Travel delays and detours are expected for Project-related closures of Mactaquac Road intermittently throughout construction, but they will not result in a drop below LOS D for key intersections. One intersection is currently operating at LOS F, and this is expected to continue during closures of Mactaquac Road. Oversized or overweight Project vehicles will only operate if NBDTI has issued a relevant permit, with associated conditions to protect the integrity of the road infrastructure.

13.6 FOLLOW UP AND MONITORING

A dedicated follow-up and monitoring plan is not required to verify the environmental effects predictions of this assessment or to verify the effectiveness of mitigation.

13.7 REFERENCES

exp (exp Services Inc.). 2015. Transportation Study of Mactaquac Project Options. Draft Report. Dated April 27, 2015.

exp. 2022. Traffic Impacts of Mactaquac Road Extended Closure. Final Report. Dated January 26, 2022.

Stantec (Stantec Consulting Ltd.). 2016. Mactaquac Project: Final Comparative Environmental Review Report. Dated August 2016.

14.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON THE SOCIOECONOMIC ENVIRONMENT

This section assesses the potential environmental interactions between the construction, and operation and maintenance phases of the Project and the socioeconomic environment valued component (VC).

14.1 RATIONALE FOR SELECTION AS A VALUED COMPONENT

The Project has the potential to interact with the socioeconomic environment, which includes land and resource use, infrastructure and services, and employment and the economy. These potential interactions concern regulatory agencies, non-governmental organizations, and the public because they can have a direct influence on the lives of those living and working in the vicinity of a project. The socioeconomic environment has therefore been selected as a VC in recognition of these concerns and values of New Brunswickers.

The main components of the socioeconomic environment, in relation to this assessment, are defined as follows:

- Land and resource use refers to the current and future use of public and private land and resources in the vicinity of the Project. It includes industrial and commercial land use, private land ownership (including potential nuisance effects), and the use of land and resources for recreational purposes (*e.g.*, hunting, boating, fishing, and hiking). The use of land and resources by Indigenous people and communities is discussed in Chapter 12.
- Infrastructure and services refers to the public services and infrastructure that are provided to local populations through various public and governmental programs, as well as the services provided by businesses and organizations to meet societal needs.
- Employment and economy refers to the labour market and availability, employment, employment income, business income, and their aggregate influence on the local, regional, and provincial economies.

For the socioeconomic environment, the potential interactions between the Project and use of land and resources, employment, the economy, and infrastructure and services in the project development area (PDA) and local assessment area (LAA) are considered.

14.2 SCOPE OF ASSESSMENT FOR SOCIOECONOMIC ENVIRONMENT

14.2.1 Regulatory Context

Land use planning in New Brunswick is regulated by the New Brunswick *Community Planning Act, 2017*. The purpose of this legislation is to support the development of environmentally, economically, socially, and culturally sustainable communities, and guide regional and local planning decisions in the development of communities.

Many of the communities within the LAA (defined later), including the City of Fredericton, the Town of Nackawic and several villages and rural communities, are municipalities with elected local governments, including a mayor and a council. The larger cities and towns also have departments that administer services to the community, including waste, water, sewer, roads, and engineering and planning services.

The Regional Service Commission 11 provides land use and regional planning services for central New Brunswick (including Fredericton and surrounding areas, including Mactaquac) (RSC 11 2022).

The Regional Development Corporation (RDC) is a Crown corporation that plans, coordinates, and implements regional and economic development initiatives for the Province of New Brunswick under the *Regional Development Corporation Act* (RDC 2022).

14.2.2 Spatial Boundaries

The assessment of potential environmental interactions between the Project and the socioeconomic environment is focused on a PDA and a LAA.

The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project. The PDA is depicted on Figure 2.1.

The LAA for the socioeconomic environment is defined as the area within which the effects of the Project can be measured or predicted. The LAA for the socioeconomic environment includes all of the City of Fredericton, and extends north to the North York area, southeast to New Maryland, and west to Nackawic. The LAA can be thought of as the “zone of influence” of the Project on the socioeconomic environment.

14.2.3 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects on the socio-economic environment include:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years.
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068.

14.3 EXISTING CONDITIONS FOR THE SOCIOECONOMIC ENVIRONMENT

14.3.1 Approach and Methods

Information on existing conditions for the socioeconomic environment was obtained from:

- Published sources including statistical data and reports from Statistics Canada, the Government of New Brunswick (various departments), and other sources.
- Past project assessments and technical reports.
- Professional judgment of the study team and knowledge of potential interactions.

14.3.2 Description of Existing Conditions

The following section describes the existing conditions for the socioeconomic environment.

Land and Resource Use

The original construction of the Mactaquac Generating Station (MQGS) and the creation of the headpond resulted in residential, commercial, and agricultural development, recreational access and opportunities, and scenic views. Most farmland upstream of the MQGS on the headpond is used for hay farming. There are also mixed farming areas along the St. John River valley, and dedicated dairy, pasture, horticultural, fruit, and vegetable farms.

The Mactaquac headpond is a popular area for both permanent residents and recreational properties. Many cottages are located near the headpond. Waterfront properties, with land access, are priced substantially higher on average than those located in-land with no waterfrontage. The headpond and its recreational infrastructure provide opportunities for various recreational activities such as camping, boating, golfing, fishing, and swimming. As described in the aquatic environment VC (Chapter 10), a commercial harvest for gaspereau (*i.e.*, alewife [*Alosa pseudoharengus*] and blueback herring [*Alosa aestivalis*]) exists at the Mactaquac dam, within the PDA (Jessop 2001).

The presence of the headpond is thought to be closely linked to the structure and dynamics of the communities along its banks, reflected in the sense of community felt by local residents near the headpond. This is reflected in the type of businesses (*e.g.*, campgrounds), presence of recreational infrastructure (*e.g.*, marinas, beaches), and creation of communities (*e.g.*, Town of Nackawic). Together, these features contribute to the appeal of the area, and are closely tied to the character of its communities. More information on land and resource use is presented in the following subsections.

Parks

There are public parks and associated public recreational access points near Mactaquac, including boat launches and trail access. Mactaquac Provincial Park (525 hectares [ha]) has a campground, two beaches, a golf course, and hiking and cycling trails. York Centennial Park, operated by the Province of New Brunswick, is located off Route 105 on the banks of the headpond and features an adventure course known as Treego Mactaquac. Kings Landing Historical Settlement is an outdoor historical museum situated on Route 102 near the community of Prince William. The settlement is a Crown Corporation of the Province of New Brunswick under the Department of Tourism, Heritage and Culture.

Protected Areas and Environmentally Significant Areas

The Nature Trust of New Brunswick, a charitable land trust dedicated to the acquisition of private lands to maintain biological diversity, has established nature preserves in the LAA, as follows.

- Burpee Bar and Sugar Island: These are part of a group of islands, referred to as the Keswick Islands, located in the St. John River between Fredericton and the MQGS. They are accessible only by boat and are undeveloped. Burpee Bar was formerly used for agricultural purposes, such as pasturing cattle, and is known for the presence of rare plants (NTNB 2022a; 2022b).

- James C. Yerxa: This is a 3 ha nature preserve on the Keswick River, and is accessible by car. It supports large hardwood trees and numerous rare plants and birds (NTNB 2022c).
- Fredericton Wildlife Refuge: This site was established in 1962 as the Fredericton Game Management Area. It is bounded by the Bill Thorpe Walking Bridge and the Princess Margaret Bridge, and by the high water line on the east and west banks of the river (FNC 2022). It is a popular area for birdwatching, and 220 bird species have been recorded in the refuge (FNC 2022).

There are Environmentally Significant Areas (ESAs) near the MQGS, including the Keswick Ridge Escarpment ESA and the Mactaquac River/Dam ESA; for more information, see Chapter 7 (Vegetation) and Chapter 8 (Wildlife).

Campgrounds

Mactaquac Provincial Park Campground is a popular destination for local residents and visitors, offering approximately 300 serviced campsites. There are also several commercial campgrounds located along the shores of the headpond, including Woolastook Family Park, River Run Resort, Everett’s Campground, Prince William Campground, and Heritage Country Camping, among others. Many of these campgrounds offer recreational opportunities such as swimming and boat access.

Trails

New Brunswick has a well-developed network of multi-use trails. The New Brunswick Trail and the TransCanada Trail both pass through Fredericton. Many municipalities also have their own trail networks that are suitable for a variety of users.

There are ten official trails located within Mactaquac Provincial Park, including a wheelchair-accessible trail along the Old Beaver Pond Trail (Parks NB 2022). The trails range in difficulty, and are shared by many different non-motorized recreationalists, including hikers, cyclists, and cross-country skiers. In the winter, the New Brunswick Federation of Snowmobile Clubs (NBFSC) uses the headpond as a connector between the provincial and local trails (NBFSC 2022).

Recreational Fishing

Recreational fishing refers to angling, sport fishing, and other non-commercial fishing activity. The province of New Brunswick is divided into eight Recreational Fishing Areas (RFAs). The MQGS is located within the Lower Saint John RFA (RFA 6), which includes all lakes, rivers, and streams of the St. John River drainage and tributaries downstream of the covered bridge in Hartland to the Saint John harbour bridge.

Recreational fishing in the Lower St. John River and headpond generally focuses on smallmouth bass, trout, and muskellunge (commonly known as muskie). Fishing for Atlantic salmon is prohibited in RFA 6 (Province of New Brunswick 2022a). Catch and release fishing for smallmouth bass, an invasive species, in the river system is a popular pastime. Open season for trout fishing within the St. John River extends from April to September, except in lakes, ponds, and reservoirs (such as the headpond) where it is open from May to September (Province of New Brunswick 2022a).

Currently, individuals use the MQGS property to access the St. John River for recreational fishing. Although the MQGS property is private, access is not controlled. Recreational fishing also occurs at the other side of the river, below the dam.

Hunting, Trapping and Harvesting

The Province has established Wildlife Management Zones (WMZ) to help manage wildlife populations and hunting (Province of New Brunswick 2017). WMZ 16 follows the north side of the St. John River west of Fredericton and is a popular area for hunting white-tailed deer. In 2021, 8,045 white-tailed deer were harvested, compared to 7,776 in 2020 (NBDNRED 2021). Other large game hunted in the province include moose and black bear. In addition to large and small game hunting and trapping, waterfowl hunting occurs, typically in agricultural areas near waterbodies and in wetlands.

Fiddlehead (ostrich) fern (*Matteucia struthiopteris*) is common in the St. John River valley. This traditional food is most abundant in wet areas and islands along streams and rivers and is considered a seasonal (spring) delicacy. In several locations along tributaries to the St. John River, this species grows in sufficient quantities that it can be harvested for personal use and for local sale.

Navigation and Marinas

Recreational boating within the St. John River and headpond is a popular pastime for many residents and visitors, and is strongly linked to other activities, such as fishing, waterfowl hunting, and tourism. There are several public recreational access points along the headpond. Common routes travelled by boaters include the area surrounding Mactaquac Provincial Park and coves located along the river (*e.g.*, Wheelers Cove, Jewett's Cove, and Steeple Cove near Kings Landing). A variety of motorized and non-motorized watercraft, including sailboats, ice boats, pontoon boats, and house boats use the river and headpond.

York Centennial Park Marina is located off Route 105 on the shore of the headpond, a few kilometres south of the Mactaquac Provincial Park entrance. The marina is home to the Mactaquac Sailing Association. The Mactaquac Provincial Park has a privately operated marina, also located off Route 105 near Mactaquac Beach. Lakehouse Boat Rentals is located at the Mactaquac marina, where three types of houseboats are available for rental.

The Regent Street Wharf is located downstream of the MQGS within the City of Fredericton. The wharf offers seasonal dock and mooring space to members and visitors from June to September. It is managed by the Capital City Boat Club.

The Port Fredericton Marina is a full-service marine located in Lower St. Mary's, southwest of Fredericton. The marine offers seasonal rates and weekend rates, in addition to power boat slips, and canoe and kayak slips and storage.

Infrastructure and Services

Housing and Accommodations

York County, which encompasses the MQGS and west-central New Brunswick including Fredericton and Nackawic, had a population of 105,261 people in 2021 (Statistics Canada 2022a). The population of York County increased by 5.8% from 2016 to 2021. There were 45,260 occupied private dwellings in 2021; 61% were single detached houses (Statistics Canada 2022a).

In 2021, the City of Fredericton had a population of 63,116 people (Statistics Canada 2022a). The population increased by 7.5% from 2016 to 2021. There were 28,475 occupied private dwellings in 2021; 44% were single detached houses (Statistics Canada 2022a).

Temporary Accommodations

Temporary accommodations are short-term, temporary, or transient accommodations, such as hotels, motels, or boarding houses. New Brunswick's Department of Tourism, Heritage and Culture collects tourism and accommodation data for the Province. In 2021, the occupancy rate for temporary accommodations in Fredericton was 37%, which is the same occupancy rate for the province of New Brunswick in 2021. In 2020, the occupancy rate for Fredericton and the province as a whole was 27%. These occupancy rates are lower than previous years due to the COVID-19 pandemic; the occupancy rate in Fredericton and the entire province in 2019 was 58% and 57%, respectively (New Brunswick Department of Tourism, Heritage and Culture 2019; 2020; 2021). According to the City of Fredericton, there are 31 hotels, motels, resorts, bed-and-breakfasts, inns, and tourist homes in the city (City of Fredericton 2022a). There are also several campgrounds in the Fredericton and Mactaquac areas.

Education Facilities

There are seven school districts in New Brunswick: four anglophone districts and three francophone districts. The educational institutions in the LAA are located within the Anglophone West School District and the District Scolaire Francophone Sud.

There are three francophone schools in the Fredericton area: École des Bâtisseurs, École des Éclaireurs, and École Sainte-Anne (District Scolaire Francophone Sud 2022). There are no francophone schools located to the west of Fredericton. There are more than 25 anglophone schools in the Fredericton area alone, which serve more than 13,000 students from kindergarten to Grade 12 (City of Fredericton 2022b). The City of Fredericton is also home to two universities (The University of New Brunswick and St. Thomas University) and several colleges and private training institutions (City of Fredericton 2022b).

Policing and Search and Rescue

The Royal Canadian Mounted Police (RCMP) and the Fredericton Police Department manage policing services in the LAA. The New Brunswick RCMP Headquarters is located in Fredericton. The RCMP employs 1,254 people in New Brunswick; 856 of which are uniformed members (RCMP 2022). The Fredericton Police Department employs 109 officers and 27 civilians (City of Fredericton 2022c).

The York Sunbury Search and Rescue (YSSR) is responsible for assisting police with search and rescue activities. In 2020, there were 88 volunteers and the YSSR responded to 11 calls, totaling 110 person hours of rescue effort (YSSR 2020).

Fire Protection

York County is served by several fire departments. The Fredericton Fire Department provides emergency response services including fire suppression, first aid, water and rescue, ice/water rescue, hazmat, and motor vehicle extrication to Fredericton and surrounding local service districts. The Upper Kingsclear Fire Department provides emergency fire services on the south side of the St. John River from Island View to Yoho Lake in the south and Lake George in the west (including the communities of Central Kingsclear, Island View, and Longs Creek). The department also serves a section of the Hanwell Rural Community. The North York Fire Department and Keswick Ridge Fire Department serve communities on the north side of the Saint John River. The service area of the Keswick Ridge Fire Department also includes the communities of Mactaquac, Jewetts Mills, French Village, and Queensbury Parish.

Health Services

Health care facilities in New Brunswick are managed by two Regional Health Authorities: Horizon Health Network and Vitalité Health Network. They are responsible for delivering services in hospitals and community health centres and providing extra mural programs, addictions, mental health, and most public health services. Health care facilities in the LAA are under the jurisdiction of the Horizon Health Network. The Dr. Everett Chalmers Regional Hospital in Fredericton provides primary health care services and health promotion programs. Addiction and mental health services are provided by Horizon Health Network and Vitalité Health Network.

The Stan Cassidy Centre for Rehabilitation in Fredericton offers in-patient and out-patient adult and paediatric rehabilitation services and assistive technology services. The Veterans Health Unit in Fredericton provides long-term care for veterans. There are a variety of doctors' offices and community health clinics located in major centres throughout the LAA.

Ambulance services in the province of New Brunswick are the responsibility of the New Brunswick Department of Health. The department has granted licensing and authority to Ambulance New Brunswick (ANB) to provide these services, employ more than 10,000 health care workers, including primary care paramedics, emergency medical dispatchers, and critical care flight nurses (ANB 2022).

The Fredericton Extra Mural Program Service Delivery Unit provides acute care, palliative care, chronic care, long-term care, rehabilitation, and home oxygen therapy. These services are provided in home, at nursing homes, in schools, and in the community.

Water and Wastewater

The Saint John River and headpond have been a valued water resource for many years. Many municipalities bordering the river and headpond, including the Town of Oromocto, City of Fredericton, Town of Nackawic, Kingsclear and Woodstock First Nations, and Town of Woodstock provide wastewater and storm water treatment for residents. Treated wastewater is subsequently released into the Saint John River and/or headpond. In addition, water is pumped from the river/headpond for fire response or for other purposes (*e.g.*, irrigation). Major surface water users (*e.g.*, intakes and outfalls) are discussed further in Chapter 9 (Water Resources).

Employment and the Economy

Economy

The New Brunswick economy has traditionally been based largely on natural resources. Historically, the forestry sector was an economic driver in the province, but its economic contribution has been decreasing (Province of New Brunswick 2010). The gross domestic product (GDP) for all industries in New Brunswick was $31,630 million in 2021 (Statistics Canada 2022b); the GDP for industrial production was $4,742 million, manufacturing was $3,094 million, the energy sector was $1,735 million, and forestry and logging was $317 million (Statistics Canada 2022b).

Tourism contributes substantially to the provincial economy. In 2022, 40,000 employees worked in the tourism sector (Province of New Brunswick 2022b). That same year, the GDP for tourism, heritage, arts, sports, and culture sector of the province was $1,300 million (Province of New Brunswick 2022b).

Labour and Employment

As of August 2022, New Brunswick’s labour force numbered approximately 396,100 people, with 368,500 employed and an unemployment rate of 7% (Statistics Canada 2022c). The national Canadian average unemployment rate is 5.1% (Statistics Canada 2022c). The 2016 census labour force statistics (most recently available data) in New Brunswick, York County, and Fredericton are presented in Table 14.1.

Table 14.1 New Brunswick, York County, and Fredericton Labour Force Statistics, 2016

Location	Labour Force	Employed	Participation Rate (%)[1]	Employment Rate (%)[2]	Unemployment Rate[3]
New Brunswick – Total	381,790	339,045	61.5	54.7	11.2
New Brunswick – Males	197,005	170,050	65.3	56.4	13.7
New Brunswick - Females	184,790	168,995	58	53	8.5
York County - Total	52,950	48,085	64.7	58.7	9.2
York County - Males	26,865	23,960	67.9	60.6	10.8
York County - Females	26,085	24,125	61.7	57	7.5
Fredericton - Total	31,505	28,735	65.2	59.4	8.8
Fredericton - Males	15,725	14,195	68.8	62.1	9.7
Fredericton - Females	15,780	14,540	62	57.1	7.9

Notes:
[1] The participation rate is the percentage of the working-age population employed or actively looking for employment.
[2] The employment rate is the number of employed persons expressed as a percentage of the total population 15 years and older.
[3] The unemployment rate is the number of unemployed persons expressed as a percentage of the labour force.
Note, totals may not add due to rounding.
Source: Statistics Canada (2017)

The table below provides an overview of the experienced labour force by industry in New Brunswick in 2016 (Statistics Canada 2017). The health care and social assistance sector accounts for most of the labour force in New Brunswick (*i.e.*, 51,380 people, or approximately 14% of the employed population), followed by the retail trade and public administration. Females represent 85% and 54% of the health care and social assistance, and retail trade labour force, respectively (Statistics Canada 2017).

Table 14.2 New Brunswick and York County Labour Force by Industry Statistics, 2016

Labour Industry*	Labour Force by Industry in New Brunswick			Labour Force by Industry in York County		
	Total	Males	Females	Total	Males	Females
Health care and social assistance	51,380	7,955	43,430	6,280	1,045	5,235
Retail trade	46,180	21,220	24,950	6,260	2,870	3,390
Manufacturing	32,405	23,215	9,195	2,045	1,490	555
Public administration	32,090	17,960	14,135	7,175	3,850	3,325
Construction	27,795	25,195	2,595	3,215	2,875	340
Educational services	26,090	8,180	17,905	5,340	2,030	3,310
Accommodation and food services	24,825	8,460	16,365	3,665	1,460	2,205
Administrative and support; waste management and remediation services	18,530	10,060	8,475	2,200	1,170	1,030
Transportation and warehousing	17,680	13,295	4,390	1,825	1,360	465

Table 14.2 New Brunswick and York County Labour Force by Industry Statistics, 2016

Labour Industry*	Labour Force by Industry in New Brunswick			Labour Force by Industry in York County		
	Total	Males	Females	Total	Males	Females
Professional; scientific and technical services	17,240	9,485	7,750	3,935	2,390	1,540
Other services (except public administration)	17,105	8,365	8,745	2,285	1,080	1,215
Agriculture; forestry; fishing and hunting	15,135	12,025	3,115	980	705	275
Finance and insurance	12,415	4,090	8,325	1,440	505	935
Wholesale trade	11,170	8,180	2,990	1,215	990	225
Other	7,320	3,790	3,530	965	425	545
Information and cultural industries	6,615	3,700	2,915	1,320	820	495
Arts; entertainment and recreation	5,950	3,065	2,885	820	435	380
Mining; quarrying; and oil and gas extraction	4,345	3,765	580	245	225	20
Real estate and rental and leasing	3,830	2,245	1,585	795	465	335
Utilities	3,350	2,615	735	895	635	260
Management of companies and enterprises	345	145	195	60	45	15

Notes:
Totals may not add due to rounding.
*Industry – North American Industry Classification System 2012
Source: Statistics Canada (2017)

14.4 EFFECTS ASSESSMENT

14.4.1 Assessment Criteria

14.4.1.1 Residual Effects Characterization

Table 14.3 presents definitions for the characterization of residual environmental effects on the socioeconomic environment. The criteria are used to describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures have been developed, where possible, to characterize residual effects. Qualitative considerations are used where quantitative measurement is not possible.

Table 14.3 Characterization of Residual Effects on Socioeconomic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to the socioeconomic environment **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to the socioeconomic environment
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible –** no measurable change from baseline conditions. **Low –** a small, measurable change in • Land and resource use capacity, but land and resource use activities can take place at or near current levels • Capacity of services and infrastructure, but will be near baseline conditions • Employment and the economy, but residual effect cannot be distinguished from baseline conditions within normal range of variability **Moderate –** a measurable change in • Land and resource use capacity that is greater than low, but land and resource use activities can take place at or near current levels • The demand for services and infrastructure which exceeds the current capacity and baseline conditions but do not result in a reduction in standards or service • Employment and the economy that is greater than low, but residual effect cannot be distinguished from baseline conditions within normal range of variability **High –** a measurable change in • Land and resource use capacity, such that land and resource use activities cannot take place at or near current levels • The demand for services and infrastructure which exceed current capacity and will result in a reduction in standards or service • Employment and the economy that is likely to result in serious risk or benefit
Geographic Extent	The geographic area in which a residual effect occurs	**PDA –** residual effects are restricted to the PDA **LAA –** residual effects extend into the LAA
Duration	The period of time required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term** – residual effect extends for less than 1 year **Medium term** – residual effect extends through the construction phase **Long term** – residual effect extends through the operation phase **Permanent –** recovery to baseline conditions unlikely

Table 14.3 Characterization of Residual Effects on Socioeconomic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations are noted in the evaluation of the residual environmental effect, where applicable or relevant	**Not applicable –** timing does not affect the VC **Applicable –** timing affects the VC
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** **Multiple irregular event –** occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed
Ecological and Socioeconomic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

14.4.1.2 Significance Definition

A significant adverse residual effect on socioeconomic environment is defined as one that:

- The Project will result in change or disruption that restricts or degrades present land and resource use capacity to a point where activities cannot continue at or near current levels and where compensation is not possible,
- Exceeds the available capacity or substantial decrease in available services, on a persistent or ongoing basis, or
- Results in an adverse effect to employment or the economy that is highly distinguishable from current conditions and trends and cannot be managed or mitigated through changes to programs, policies, plans or other mitigation actions

14.4.2 Potential Project Interactions with the Socioeconomic Environment

Activities and components could potentially interact with the socioeconomic environment to result in adverse environmental effects on the socioeconomic environment. In consideration of these potential interactions, the assessment of Project-related environmental effects on the socioeconomic environment is therefore focused on the potential environmental effect listed in Table 14.4. These potential environmental effects will be assessed in consideration of specific measurable parameters, also listed in Table 14.4.

Table 14.4 Potential Environmental Effect and Measurable Parameters for the Socioeconomic Environment

Potential Environmental Effect	Effect Pathways	Measurable Parameters
Change in the socioeconomic environment	• Project activities may result in the loss of access or loss of area available for recreational use • Project activities incompatible with applicable land use plans and/or economic development plans • Project demand for labour • Project expenditures • Demand on housing and temporary accommodations	• Area (hectare) of land affected (*e.g.,* access restrictions, recreational land use) • Consistency with established land use and/or economic development plans • Direct employment (number of jobs) • Project expenditures on goods and services • Availability of accommodations in the LAA (such as vacancy rates, inventory levels)

Table 14.5 identifies the physical activities that may interact with the VC and result in an environmental effect. These interactions are discussed in detail in the following sections, including potential environmental effects, mitigation and environmental protection measures, and residual environmental effects.

Table 14.5 Potential Interactions Between Physical Activities and Socioeconomic Environment

Physical Activities	Change in the socioeconomic environment
Construction	
Site preparation	✓
In-water work (*intake: concrete repairs, heavy mechanical, dewater water passage; powerhouse: concrete repairs, dewater water passage*)	-
Insolated work in the dry (*intake: waterproofing and sealing, heavy mechanical; powerhouse: turbine-generator work*)	-
Work above water line (*intake: aux. mechanical, electrical systems, architectural; powerhouse: AAR mitigation, concrete repairs; penstock, aux. mechanical, electrical systems, architectural)*	-
Shut down of power units	-
Fish passage	-
Transportation (*powerhouse: transportation of equipment)*	✓
Employment and expenditure	✓
Operation and Maintenance	
Operation of the MQGS	-
Maintenance of the MQGS	-
Fish passage	-
Notes: ✓ = Potential interaction – = No interaction	

There will be no Project-related changes to the socioeconomic environment during operation and maintenance of the MQGS following completion of the construction of the Project. Following construction of the Project, there will be no changes distinguishable from existing conditions. As such, residual effects are not anticipated during operation and maintenance; they are by definition rated not significant, and the operation and maintenance phase is not discussed further in respect of this VC.

14.4.2.1 Potential Effects to the Socioeconomic Environment During Construction

The following subsections describe the potential interactions between the construction of the Project components and the socioeconomic environment.

The footprint of the Project is located on land owned by NB Power. During construction, access to MQGS property will be controlled for safety and security. Access to the river for recreational fishing will therefore not likely be available during this period. The commercial gaspereau harvest will continue throughout the Project, and while the location of the collection may change as temporary fish passage is implemented, other changes to the harvest are not anticipated. The other components of land and resource use discussed above, including parks, protected areas, campgrounds, trails, land used for hunting, trapping and harvesting, and marinas, are not expected to be affected by construction of the Project.

Nuisance dust and noise emissions are expected from construction activities and from the use of heavy mobile equipment, which could affect nearby residents, and other land and resource users.

Temporary closures of Mactaquac Road could affect travel route for emergency service providers, such as ambulance, fire, and police. NB Power will communicate planned closures well in advance to allow emergency response organizations time to prepare for the closure and potentially reposition resources.

Construction of the Project is expected to last for approximately 12 years. The workforce is expected to be relatively steady throughout the construction process and there are no expectations of big peaks in labour demand due to the Project. There will be opportunities for local businesses and contractors during the construction period. Housing and temporary accommodations are expected to experience higher occupancy rates during the construction period as workers come into the area temporarily.

Employment opportunities during construction could affect people of different genders and cultures differently. These potential effects will be managed with mitigation measures identified below.

Education facilities and public health services are not expected to be affected by construction of the Project.

14.4.3 Mitigation for the Socioeconomic Environment

Interactions between Project activities and the socioeconomic environment will be managed with mitigation. The following mitigation measures specific to the socioeconomic environment have been identified for this Project.

- Existing access roads will be used to the extent possible for the transportation of construction equipment and materials.
- Road closures or changes to access will be communicated in advance to the public and service providers.
- Changes to access within the PDA will be communicated to the public in advance.
- Local residents and communities will be informed of job opportunities during all Project phases.
- Project purchasing requirements will be posted in advance as a benefit to local and regional businesses.
- NB Power will liaise with local emergency providers so that roles and responsibilities are understood and that the necessary resources are in place.
- NB Power employees and contractors will adhere to policies and procedures that encourage safety, responsibility, integrity, diversity, inclusion and fair employment.

14.4.4 Characterization for Residual Project Environmental Interactions for the Socioeconomic Environment

Changes to the socioeconomic environment as a result of nuisance noise and dust will be controlled with the mitigation measures described in Chapter 6 (atmospheric environment). As discussed in Chapter 6, the release of fugitive dust emissions and the generation of noise are expected to be intermittent, fluctuate during active construction, and generally be confined to the LAA.

During construction, access to the MQGS property will be controlled for safety and security. Other changes to recreational opportunities currently occurring in the LAA are not anticipated.

NB Power will communicate the Project schedule including planned road closures well in advance to the public and surrounding communities. This will allow the public and emergency response organizations time to prepare for the closure, and potentially reposition resources so that they can continue to meet their expected response times.

Changes in employment and the economy are expected to be positive since the Project will create employment and contracting opportunities for the construction period. Construction of the Project could result in competition for labour in specialized trades; however local residents, communities, and businesses will be informed of job opportunities and project purchasing requirements in advance. Project related expenditures will result in direct, indirect, and induced employment in the LAA, with increased spending for goods and services in the LAA by Project workers temporarily brought to the region to work on the Project. The increase in demand for labour and accommodation during construction of the Project is not expected to exceed the capacity of the labour market or available accommodations.

14.4.5 Summary

Overall, changes to the socioeconomic environment as a result of the Project will be both adverse and positive, low in magnitude, medium-term in duration, and reversible once Project construction is complete. A summary of the residual environmental effects on the socioeconomic environment during Project construction and operation is provided in Table 14.6**.**

Table 14.6 Project Residual Effects on the Socioeconomic Environment

Residual Effect	Residual Effects Characterization								
	Project Phase	**Direction**	**Magnitude**	**Geographic Extent**	**Duration**	**Timing**	**Frequency**	**Reversibility**	**Ecological and Socioeconomic Context**
Change in the socioeconomic environment	C	A/P	L	LAA	MT	NA	R	R	D

KEY
See Table 14.3 for detailed definitions

Project Phase
C: Construction
O: Operation and maintenance

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: Local assessment area

Duration:
ST: Short term
MT: Medium term
LT: Long term

Timing:
NA: Not Applicable
A: Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

N/A: Not applicable

14.5 DETERMINATION OF SIGNIFICANCE

With the implementation of mitigation measures, the Project will not result in an adverse environmental effect that restricts or degrades present land and resource use capacity to a point where activities cannot continue at or near current levels and where compensation is not possible. The Project will not result in exceedance of available capacity or substantial decreases in available services, on a persistent or ongoing basis, nor will it result in adverse effects to employment and the economy that are highly distinguishable from current employment and economy conditions and trends and cannot be managed or mitigated through changes to programs, policies, plans, or other mitigation actions.

In consideration of the above, the residual environmental effects of the Project on the socioeconomic environment during all phases of the Project are rated not significant, with a high level of confidence.

14.6 FOLLOW UP AND MONITORING

A dedicated follow-up and monitoring plan for the socioeconomic environment is not required to verify the environmental effects predictions of the assessment or to verify the effectiveness of mitigation.

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15.0 ASSESSMENT OF EFFECTS OF THE ENVIRONMENT ON THE PROJECT

15.1 RATIONALE FOR INCLUSION

Effects of the environment on the Project has been included in this assessment due to the potential for environmental forces, events, and environmental conditions to interact with the Project. These interactions may include naturally occurring events related to climate (including weather and its variables), climate change, flooding, seismic activity, and forest fires.

If effects of the environment on the Project are not accounted for or are left unmanaged, they can result in adverse changes to Project components and infrastructure, construction schedule, costs, and operational performance. These potential effects are addressed through project design, scheduling, and applying industry standards, best management practices and operational procedures in consideration of the expected and extreme environmental conditions.

15.2 SCOPE OF ASSESSMENT FOR EFFECTS OF THE ENVIRONMENT ON THE PROJECT

15.2.1 Spatial Boundaries

The assessment of potential environmental interactions between the Project and the effects of the environment on the Project is focused on the Project development area (PDA). The spatial boundary for effects of the environment on the Project is limited to those areas having Project-related infrastructure within them (*i.e.*, the PDA).

The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project. The PDA for the Project is defined as the area of physical disturbance associated with the construction, operation, and maintenance of the Project. As described in Section 2, for the purposes of this assessment, the PDA includes the upstream extents of the dam infrastructure, and downstream extents of the coffer dams installed during the construction phase.

As the zone of influence of effects of the environment on the Project is limited to those Project components and infrastructure, there is no need to define a local assessment area (LAA) for effects of the environment on the Project.

15.2.2 Temporal Boundaries

The temporal boundaries for the assessment of effects of the environment on the Project include:

- Construction – scheduled to begin in 2024, pending regulatory approvals, and last for approximately 12 years
- Operation and maintenance – scheduled to begin following construction and last until approximately 2068

15.2.3 Significance Definition

A significant adverse residual effect of the environment on the Project is defined as one that results in:

- A substantial change to the Project construction schedule (*e.g.*, a delay resulting in the construction period being extended by one season)
- A substantial change to the Project operation schedule (*e.g.*, an interruption in the operation of the Project such that electricity cannot be generated for a full season or more)
- Damage to the Project infrastructure resulting in increased safety risk to the public
- Damage to the Project infrastructure resulting in required repairs that could not be technically or economically implemented.

15.3 ASSESSMENT OF THE EFFECTS OF THE ENVIRONMENT ON THE PROJECT

15.3.1 Approach and Methods

The information presented below was primarily obtained from research (including a review of statistical data sources, scientific literature, and other published reports), past project assessments/technical reports that were reviewed for relevant information, and the professional judgement of the study team.

15.3.2 Climate and Climate Change

15.3.2.1 Existing Conditions

Climate

Climate is defined as the long-term average, seasonal, and extreme meteorological conditions in an area, which includes measurable parameters such as temperature, precipitation, and winds, among others. Environment and Climate Change Canada (ECCC) has developed statistical summaries of data collected from weather stations located across Canada (typically a 30 year record, with the most recent data available being for the period of 1981 to 2010), known as climate normals data. As of August 2022, more recently available climate normals data than 1981 to 2010 are not available. The nearest weather station to the Project is located at the Fredericton airport weather station (station name: Fredericton A) (ECCC 2022).

Measurements from the Fredericton airport weather station indicate that January is typically the coldest month of the year, with a daily average temperature of -9.4°C. July is usually the warmest month of the year with a daily average temperature of 19.3°C. The annual average precipitation at the Fredericton airport weather station is 1,078 mm, with November being the month with the most rain and January being the month with the most snow (ECCC 2022).

The maximum hourly wind speed at the Fredericton airport weather station (80 kilometres per hour [km/h]) was observed in February. The monthly average wind speeds are lowest in August. The wind direction is generally west/northwest in the colder months, and south in the summer (May to August).

Extreme Weather Events

The Government of Canada lists severe storms and storm surges, hurricanes, tornadoes, earthquakes, floods, landslides, and forest fires amongst New Brunswick’s potential natural risks and hazards (Government of Canada 2022).

Extreme storms in New Brunswick tend to be more common and severe in the winter. Winter storms can consist of high winds and a mix of snow, rain, and ice. Hurricane season occurs between June to November. The centre of the hurricane (called the eye of the storm) is surrounded by very strong winds; a minimum of 120 km/h (Government of Canada 2022). A recent hurricane to affect New Brunswick, hurricane Dorian, occurred in September 2019. Hurricane Dorian resulted in power outages for 80,000 clients and damage in 24 municipalities (NBDELG 2019). Although tornadoes do occasionally occur in New Brunswick, they are rare. Landslides also occasionally occur in New Brunswick; however, the susceptibility in the province is low (Geologic Survey of Canada 2012).

Seismic activity (earthquakes), flooding, and forest fires are discussed more below in Sections 15.3.3, 15.3.4, and 15.3.5, respectively.

Climate Change

Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as “*a change in the state of climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer”* (IPCC 2014). Climate change can be due to natural forces (such as solar cycles or volcanic eruptions) or to human activities that cause changes to the atmosphere and land use (IPCC 2014).

As discussed in Chapter 6 (Atmospheric Environment), the release of greenhouse gases (GHGs), on a global scale, increases worldwide concentrations of GHGs in the atmosphere, and they are a contributor to climate change (IPCC 2014). These gases absorb and trap heat in the atmosphere, creating a natural phenomenon commonly called the “greenhouse effect”. An increase in GHGs in the atmosphere intensifies the greenhouse effect.

Predictions of future climate change are derived from mathematical and statistical models. The results obtained from climate change prediction models can be used as a guide for Project planning and can facilitate Project design and adaptation. Researchers and scientists have predicted that over the next 50 years, Atlantic Canada is likely to experience warmer temperatures, increased precipitation, more frequent and intense storm events, and increased flooding (Poitras *et al*. 2022, Dietz and Arnold 2021, Comeau and Nunes 2019).

15.3.2.2 Project Interactions with Climate and Climate Change

Climate (including extreme weather events) and climate change could potentially result in the following effects on the Project:

- Damage to infrastructure and equipment
- Delays in receipt of materials and supplies (*e.g.*, construction materials) and in delivering products
- Delays in construction activities
- Reduced visibility and inability to manoeuver equipment
- Delays in operation activities
- Inability of personnel to access the site (*e.g.*, if a road were to wash out, or poor driving conditions)
- Increased structural loading
- Loss of electrical power resulting in potential loss of production

In addition to the effects listed above, it is expected that future climate change could result in increased ambient temperatures, increased frequency and intensity of precipitation and storm events, and increased incidence of flooding and erosion. Flooding is assessed below in Section 15.3.4.

15.3.2.3 Mitigation

Interactions between climate and climate change and the Project will be managed through the following mitigation measures:

- The Project will be designed and constructed to meet applicable engineering codes, standards and best management practices. These include applicable building safety, industry codes, and standards including the National Building Code of Canada, the National Fire Code of Canada, and applicable Canadian Standards Association (CSA) Standards.
- Extreme weather, rainfall and winter precipitation will be taken into account in Project design, including the selection of materials and equipment, planning and maintenance of the Project.
- Delays due to poor weather will be anticipated and can often be predicted; allowance for them will be included in the construction schedule.
- The potential effects of extreme weather, including storms, precipitation, flooding/ice jams, and drought will be considered in Project design, operation and maintenance, including the selection of materials and equipment.
- NB Power will monitor any observed effects of the environment on the Project, and will take action as required to maintain, repair, and upgrade Project infrastructure as required, and modify operations to facilitate its continued safe operation.
- The Project design will consider normal and extreme weather conditions that may arise and will implement measures for climate adaptation.
- The Project will adhere to a Project-specific environmental management plan.

15.3.2.4 Residual Effects

Extreme weather, including large amounts of heavy snow, freezing rain, and ice could potentially damage infrastructure and construction equipment, especially if ice and wet snow builds to a point where structures are unable to withstand the weight. High winds can damage buildings, fences, and other outdoor structures. These effects will be considered in Project design and maintenance, including the selection of materials and equipment to withstand extreme weather, rainfall, and winter precipitation.

Storms with high winds and heavy precipitation can cause delays in the receipt of construction materials and supplies, delays in construction activities and operation of the Project. Delays due to poor weather will be anticipated and can often be predicted; allowance for them will be included in the construction schedule.

Heavy precipitation can result in reduced visibility and inability to maneuver construction equipment on site. Poor driving conditions or damage to infrastructure could result in the inability of personnel to access the site. Extreme weather conditions can also cause electricity outages. NB Power will monitor any observed effects of the environment on the Project, and will take action as required to maintain, repair, and upgrade Project infrastructure as required, and modify operations to facilitate its continued safe operation.

The effects of climate change (*e.g.,* warmer temperatures, increased precipitation, frequent and intense storm events, and increased flooding) will be considered in project design and NB Power will implement measures for climate adaptation.

The potential effects of climate and climate change on the Project will be considered and incorporated into planning, design, construction and operation of the Project to reduce the potential for long-term damage to infrastructure and equipment, and changes to construction and operation of the Project. Inspection and maintenance programs will be implemented to prevent the deterioration of Project infrastructure and will help the Project comply with the applicable design criteria, best management practices, standards and codes, and will maintain the reliability of the Project. The mitigation listed above will reduce the potential effects of climate and climate change on the Project. Therefore, substantive changes to the Project from climate and climate change are not anticipated.

15.3.3 Seismic Activity

15.3.3.1 Existing Conditions

Seismic activity (earthquakes) in New Brunswick has been rare; the Geologic Survey of Canada assesses the relative hazard for the Fredericton and surrounding areas to be moderate (meaning there is a 5% to 15% chance that significant damage will occur every 50 years) (Geologic Survey of Canada 2015).

15.3.3.2 Project Interactions with Seismic Activity, and Residual Effects

Project structures will be built in accordance with industry standards to withstand seismic events. It is therefore not anticipated that there will be likely interaction between seismic activity and the Project. Therefore, seismic activity is not considered further in this chapter.

In the extremely unlikely event that an earthquake that far exceeds the design seismic event were to occur and cause the dam to breach, the potential environmental effects are discussed in the accidents, malfunctions, and unplanned events (Section 17).

15.3.4 Flooding

15.3.4.1 Existing Conditions

New Brunswick has a long history of flooding, especially along the St. John River (Wolastoq). River valleys and flood plains can pose a risk to flooding because of ice jams and the floods of annual spring thaw (Government of Canada 2022). Rising water levels during the spring freshet can lead to flooding. In April 2018, severe flooding occurred along the St. John River between the MQGS and the Saint John Harbour. Areas of Fredericton and Saint John were evacuated, bridges and roads were closed (including the TransCanada highway between Fredericton and Moncton), and sewage systems were compromised, leading to water contamination (Service NB 2022; The Weather Network 2022).

15.3.4.2 Project Interactions with Flooding

Flooding could potentially result in the following effects on the Project:

- Damage to infrastructure and equipment
- Delays in receipt of materials and supplies (*e.g.*, construction materials) and in delivering products
- Delays in construction activities
- Delays in operation activities
- Inability of personnel to access the site (*e.g.*, if a road were to wash out, or poor driving conditions)
- loss of electrical power resulting in potential loss of production

In addition to the effects listed above, flooding could result in erosion, sedimentation, and failures in erosion/sedimentation control structures. Flooding is discussed in greater detail in the accidents, malfunctions, and unplanned events discussion (Section 17).

15.3.4.3 Mitigation

Interactions between flooding and the Project will be managed through the following mitigation measures:

- The Project will be designed and constructed to meet applicable engineering codes, standards and best management practices. These include applicable building safety, industry codes, and standards.
- The potential effects of flooding will be considered in Project design, operation and maintenance, including the selection of materials and equipment.

- NB Power will monitor any observed effects of the environment on the Project, and will take action as required to maintain, repair, and upgrade Project infrastructure as required, and modify operations to facilitate its continued safe operation.
- The Project design will consider normal and extreme weather conditions that may arise.
- The Project will adhere to the Project-specific environmental management plan.

15.3.4.4 Residual Effects

Flooding could damage infrastructure and equipment or result delays in construction activities and operation of the Project. These effects will be considered in Project design, operation and maintenance, including the selection of materials and equipment to withstand the impacts of flooding.

Flooding could result in delays in the receipt of materials and supplies and in delivering products. Flooding could also result in the inability of personnel to access the site (*e.g.,* if a road is washed out or if driving conditions are poor) and can cause electricity outages. Delays due to flooding events can often be predicted; NB Power will monitor any observed effects of the environment on the Project, and will take action as required to maintain, repair, and upgrade Project infrastructure as required. Operations will be modified when necessary to facilitate its continued safe operation.

The potential effects of flooding on the Project will be considered and incorporated into planning, design, construction and operation of the Project to reduce the potential for long-term damage to infrastructure and equipment, and changes to construction and operation of the Project. Inspection and maintenance programs will be implemented to prevent the deterioration of Project infrastructure and will help the Project comply with the applicable design criteria, best management practices, standards and codes, and will maintain the reliability of the Project. The mitigation listed above will reduce the potential effects of flooding on the Project. Therefore, substantive changes to the Project from flooding are not anticipated.

15.3.5 Forest Fires

15.3.5.1 Existing Conditions

Natural Resources Canada collects statistical summaries of data across Canada (1981 to 2010), known as fire weather normals data. The data is presented as Fire Weather Index (FWI), a numeric rating of forest fire intensity (NRCan 2022). The FWI in New Brunswick is rated between 0-10 during forest fire season (May to September). This is on the low end of possible forest fire risk, with the highest rating being over 30 on the FWI scale.

The PDA is primarily mowed lawns and parking areas. As such, the risk of forest fires occurring within the PDA is low, and forest fires are therefore not considered further in this chapter.

15.4 SUMMARY AND DETERMINATION OF SIGNIFICANCE

With the implementation of mitigation and environmental protection measures as described in this assessment, there are no environmental attributes that are anticipated to have the potential to result in:

- A substantial change to the Project construction schedule (*e.g.,* a delay resulting in the construction period being extended by one season).
- A substantial change to the Project operation schedule (*e.g.,* an interruption in the operation of the Project such that electricity cannot be generated for a full season or more).
- Damage to the Project infrastructure resulting in increased safety risk to the public.
- Damage to the Project infrastructure resulting in required repairs that could not be technically or economically implemented.

Effects of the environment on the Project are expected to be limited and well managed. Therefore, the residual effects of the environment on the Project during all phases are predicted to be not significant.

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16.0 CUMULATIVE ENVIRONMENTAL EFFECTS

The potential cumulative environmental effects that could arise from the Project in combination with other past, present, or reasonably foreseeable future projects or activities are assessed in this section.

16.1 SCOPE

Cumulative environmental effects are the residual environmental effects that are likely to result from a project in combination with the environmental effects of other projects or activities that have been or will be carried out (also referred to as past, present, and reasonably foreseeable future projects or activities) (CEAA 2014).

An assessment of cumulative environmental effects is warranted if both of the following conditions are met:

- The Project is assessed as having residual environmental effects on one or more valued components (VCs), whether those residual environmental effects are significant or not.
- The residual environmental effects of the Project on the identified VCs could act cumulatively (or overlap spatially and temporally) with the residual environmental effects of other past, present, or reasonably foreseeable future projects or activities.

The existing environmental conditions described for each of the VCs in Chapter 3, and Chapters 6 to 14, generally encompass the cumulative environmental effects of past and present projects or activities. However, there is also a need to assess the potential for Project-related cumulative environmental effects with respect to potential interactions with other pending projects or activities that are in advanced planning or development stages (referred to as reasonably foreseeable projects or activities), or existing projects or activities that may be subject to modifications or expansion. In such cases, a cumulative environmental effects assessment is completed to determine if there is potential for substantive interaction on a VC from the residual effects of the Project combined with those of such other projects or activities. Following the application of mitigation, the residual cumulative environmental effects are then evaluated.

The cumulative environmental effects assessment methodology undertaken for the Project, and as presented in this section, generally conforms (at a high level) to the approach recommended in the Canadian Environmental Assessment Agency's (now the Impact Assessment Agency of Canada) publication titled "Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012* – Interim Technical Guidance*"* (CEAA 2018).

16.2 SPATIAL AND TEMPORAL BOUNDARIES

The spatial boundaries for the assessment of cumulative environmental effects are defined by a regional assessment area (RAA) that is common for all VCs. The RAA is defined as the area within which potential cumulative environmental effects are assessed.

For the purpose of this cumulative environmental effects assessment, the RAA for this Project includes York County, New Brunswick. This RAA has been selected because it encompasses the Project development area (PDA) and local assessment areas (LAAs) of all VCs assessed for the Project, and because it covers an area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out.

Temporal boundaries for the assessment of cumulative environmental effects are the same for each VC as identified in Chapter 2. These temporal boundaries encompass periods of construction, and operation and maintenance of the Project.

16.2.1 Significance Criteria

The significance of cumulative environmental effects is determined based upon specified significance criteria. Thresholds of significance for the assessment of cumulative environmental effects are the same as for each applicable VC, as identified in the respective VC chapters.

16.2.2 Description of Other Projects or Activities

Reasonably foreseeable future projects or activities are defined as those that either:

- Have been publicly announced with a defined schedule and sufficient project details that allow for a meaningful assessment;
- Are currently undergoing an environmental assessment;
- Are in a permitting process; or
- Are approved but not yet operational.

A review of the public registries of the New Brunswick Department of the Environment and Local Government (NBDELG) and the Impact Assessment Agency of Canada (IAAC) identified the projects provided in Table 16.1. The locations of these projects are shown on Figure 16.1. Note that, for relevancy, the search parameters were limited to the last five years (*i.e.*, 2018 to present).

Table 16.1 Project and Physical Activity Inclusion List - Reasonably Foreseeable Future Projects

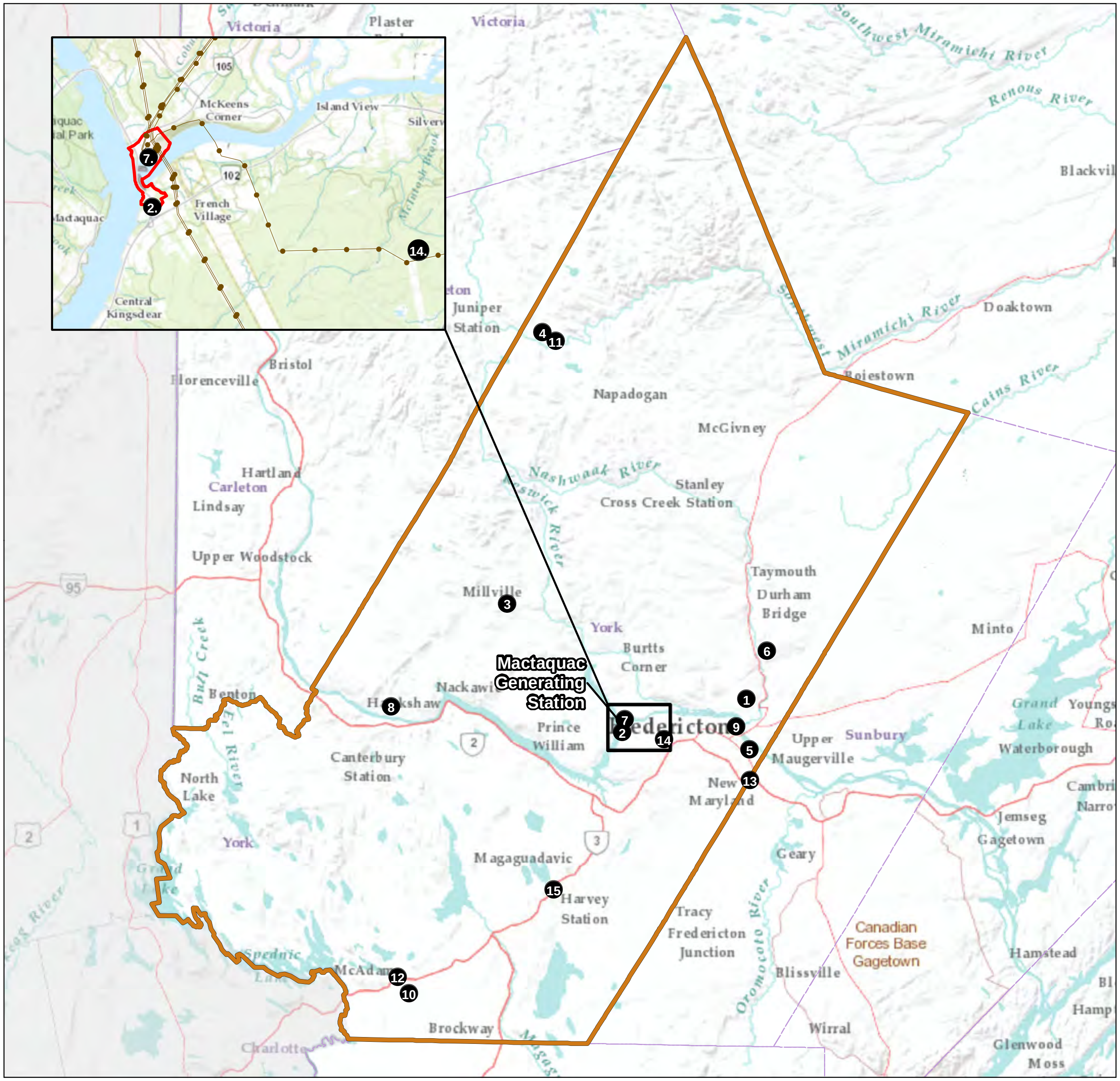
Source of Project Information	Date Registered	Project Name	Approximate Distance from Project (Line of Sight)	Project Scope
IAAC Public Registry	2022/03/02	St. Mary's First Nation Attenuation Pond	19 kilometres (km)	The proposed project will provide increased storage capacity for stormwater from the recent and on-going residential development within the surrounding area and help direct stormwater away from the residential area.
NBDELG Public Registry	2022/04/04	Development of Potable Groundwater Source at the Riverside Resort and Conference Centre	1.3 km	The proposed project involves the development of a potable groundwater source at the Riverside Resort and Conference Centre located in French Village.
NBDELG Public Registry	2022/05/18	Upgrade of On-Site Septic Disposal at Crabbe Mountain Ski Resort	26 km	Crabbe Mountain Investments Inc. proposes to upgrade the on-site septic disposal system which services the main lodge at the Crabbe Mountain Ski Resort, located in Central Hainesville, New Brunswick.
IAAC Public Registry	2022/06/23	Lincoln Road Infrastructure Upgrades	20 km	The City of Fredericton intends to reconstruct 585 m of Lincoln Road as part of the city's flood mitigation plans.
NBDELG Public Registry	2022/06/29	Upgrade of On-Site Septic Disposal System at J.D. Irving Deersdale Sawmill	62 km	J.D. Irving, Limited proposes to upgrade the on-site septic disposal system which services its sawmill in Deersdale, New Brunswick.
NBDELG Public Registry	2022/08/22	Residential Development in Penniac	25 km	The project involves a residential development with 76 existing single-family lots and approximately 20-30 additional proposed lots off of Route 628, north of Fredericton.
IAAC Public Registry	2022/11/25	St. Mary's First Nation – Court A Development	19 km	The proposed project will develop an area to include 5 tiny homes, 2 rowhouses (consisting of 5 units each), 7 detached homes, and a traditional learning center for school children. Sanitary and storm sewer, water and roadway services will be installed to facilitate the development.

Table 16.1 Project and Physical Activity Inclusion List - Reasonably Foreseeable Future Projects

Source of Project Information	Date Registered	Project Name	Approximate Distance from Project (Line of Sight)	Project Scope
NBDELG Public Registry	2021/09/01	Mactaquac Generating Station Alkali-Aggregate Reaction (AAR) Mitigation: Effluent and Sludge Treatment and Disposal (AAR Mitigation Project)	0 km	NB Power is currently preparing a treatment and disposal of effluent and sludge resulting from the slot-cutting of the Mactaquac Generating Station (MQGS) to mitigate the effects of the alkali aggregate reaction (AAR). The purpose is to develop options for the long-term treatment and disposal of the effluent and sludge generated by the slot-cutting, including drilling and grouting. This project is to support existing operations of the MQGS and is separate from the Mactaquac Life Achievement Project (MLAP).
NBDELG Public Registry	2020/01/27	Nackawic Marina Development	36 km	The proposed project involves the construction of a recreational wharf and associated infrastructure near downtown Nackawic.
NBDELG Public Registry	2020/07/22	Groundwater Supply Exploration & Testing	18 km	The City of Fredericton is proposing to develop a new groundwater protection well in its existing Queen Square wellfield.
NBDELG Public Registry	2020/08/20	McAdam Wellfield Expansion Project	54 km	The Village of McAdam is proposing the development of two new municipal production wells to obtain additional water supply capacity and provide operational redundancy.
NBDELG Public Registry	2020/10/08	Eradication of Smallmouth Bass in Miramichi	56 km	The North Shore Micmac District Council proposes to eradicate a non-native species (smallmouth bass) from Miramichi Lake, Lake Brook, and a section of the Southwest Miramichi River using a treatment that has previously been approved for use in aquatic environments in Canada by the Pest Management Regulatory Agency under Health Canada.
NBDELG Public Registry	2020/10/26	Decommissioning of McAdam Gypsum Wallboard Plant	53 km	The project will involve the decommissioning of existing infrastructure and equipment associated with the former operation of the McAdam Gypsum Wallboard Plant. The closure process is expected to occur over a period of four months followed by a care and maintenance period as well as a monitoring period.

Table 16.1 Project and Physical Activity Inclusion List - Reasonably Foreseeable Future Projects

Source of Project Information	Date Registered	Project Name	Approximate Distance from Project (Line of Sight)	Project Scope
NBDELG Public Registry	2020/11/03	Fredericton Landfill Maximum Height Increase Project	22 km	The proposed project involves increasing the maximum height of the municipal solid waste containment cells from the currently approved height of 59 metres to 88 metres. The height increase will only be in select areas to maintain a 4:1 slope of the covered landfill.
NBDELG Public Registry	2019/11/13	138 kV Reliability for Fredericton South	0.5 km	The proponent is proposing to construct and operate a new 16.1 km-long, 138 kilovolt (kV) transmission line between the Rainsford Substation in Fredericton and the Mactaquac Terminal near the MQGS.
NBDELG Public Registry	2018/09/17	Decommissioning of Sewage Treatment Lagoon at Harvey High School	28 km	The proponent proposes to decommission the existing sewage treatment lagoon at Harvey High School.



Stantec

Activity / Development Location:

1. St. Mary's First Nation Attenuation Pond/Court A Development
2. Development of Potable Groundwater Source
3. Upgrade of On-Site Septic Disposal at Crabbe Mountain Ski Resort
4. Upgrade of On-Site Septic Disposal System at J.D. Irving Deersdale Sawmill
5. Lincoln Road Infrastructure Upgrades
6. Residential Development in Penniac
7. Mactaquac Generating Station Alkali-Aggregate Reaction Mitigation: Effluent and Sludge Treatment and Disposal (AAR Mitigation Project)
8. Nackawic Marina Development
9. Groundwater Supply Exploration and Testing
10. McAdam Wellfield Expansion Project
11. Eradication of Smallmouth Bass in Miramichi
12. Decommissioning of McAdam Gypsum Wallboard Plant
13. Fredericton Landfill Maximum Height Increase Project
14. 135 kV Reliability for Fredriction South
15. Decommissioning of Sewage Treatment Lagoon at Harvey High School

Regional Assessment Area
Project Development Area
Transmission Line
County

N

0 10 20 Kilometres
(At original document size of 8.5x11)
1:950,000

Notes
1. Coordinate System: NAD 1983 CSRS New Brunswick Stereographic
2. Data Sources: Stantec, GeoNB
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Sources: Esri, USGS, NOAA

Project Location
Mactaquac
New Brunswick, CAN

Prepared on 2023-01-06

Client/Project 121415886_018
Coleson Power Group Inc.
Mactaquac Life Achievement
Environmental Impact Assessmnent

Figure No.
16.1

Title
Location of Reasonably Foreseeable Future Projects

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In addition to the reasonably foreseeable future projects with environmental effects that might overlap those of the proposed project identified in Table 16.1, three broad categories of past, present, or reasonably foreseeable future physical activities have been identified with potential to result in residual environmental effects that may act cumulatively with those of the Project:

- Ongoing interim operation of the MQGS while construction of the Project is taking place (not to be confused with the operation of MQGS following construction of the Project, which has been assessed as a Project-related effect during this phase)
- Infrastructure development and maintenance (*i.e.*, ongoing and planned maintenance and development of provincial roadways)
- Recreational use

These broad categories of activities have been selected based on the nature of the residual environmental effects of the Project that may overlap those of other activities, as well as the study team's knowledge of current activities taking place in the region.

Construction of the MQGS in 1968 and the creation of the headpond resulted in substantial changes to the local environment, particularly the aquatic environment. The local riverine environment was changed to a more lake-like environment which, combined with the obstruction to upstream and downstream fish passage, changed fish communities in the headpond. Availability of, and access to, fisheries and other resources was changed with the creation of the headpond. However, the environmental effects of the original construction of the MQGS and the creation of the headpond, along with other past and present projects or activities in the region, have been captured in the baseline environmental information used to assess and characterize the residual effects of the Project in Chapters 6 to 14; the potential cumulative environmental effects of the Project in combination with the original construction of the MQGS is thus not discussed further, since they are encompassed by the existing environmental conditions as they exist today.

The operation of the MQGS includes the passage of water through the powerhouse to generate electricity, spilling of water through the main spillway and diversion sluiceway, operation of the fish lift, and ongoing maintenance activities to maintain the reliability of the facility. The partial or full operation of the MQGS will continue throughout the construction phase of the Project, in much the same manner as it operates today (perhaps with fewer units operating, or at a reduced capacity), thus presenting an overlapping cumulative environmental effect to those Project-related effects that will occur during Project construction activities. This "interim" operation of the Project will cease upon completion of the construction phase, after which its related effects will "merge" with the ongoing operation of the MQGS following construction as a Project-related effect during the operation and maintenance phase. During this interim operation, impingement or entrainment of aquatic organisms can occur in the water intakes, which can therefore affect the health and survival of fish. This change in fish health and survival may act cumulatively with the effects of the Project; thus, the ongoing operation of the MQGS while construction of the Project is taking place is carried forward in the cumulative environmental effects assessment. The operation of MQGS following construction of the Project has been assessed as a Project-related effect during the operation and maintenance phase.

Infrastructure development and maintenance refers primarily to ongoing and planned maintenance and development of provincial roadways owned and operated by the New Brunswick Department of Transportation and Infrastructure (NBDTI). Mactaquac Road crosses the St. John River (Wolastoq) and connects Route 102 and Route 105. The road crosses the river on top of the MQGS rock-fill main dam and diversion sluiceway before crossing the left bank approach channel to the powerhouse via a 200 metre (m) bridge owned by NBDTI (exp 2015; Stantec 2016). This roadway has steady traffic volumes and is integral to the transportation of residents living in the surrounding communities (exp 2015). NBDTI is planning a project to carry out repairs to this roadway and bridge over the intake channel in 2023. According to the NBDELG's database of environmental impact assessment (EIA) registrations, no new planned infrastructure developments have been identified based on a review of projects that have been registered under the EIA Regulation (as of November 2022). Given the proximity with the PDA and level of infrastructure development and maintenance in the RAA, infrastructure development and maintenance is carried forward in the cumulative environmental effects assessment.

Recreational use in the RAA consists of both land and water-based activities, including hiking, hunting, boating, and recreational fishing. There are public parks and associated public recreational access points near Mactaquac, including boat launches and trail access, as well as nearby recreational facilities (*e.g.*, Mactaquac Provincial Park, Mactaquac Campground, Mactaquac Golf Course, Centennial Park, Treego, and others.

Recreational boating within the St. John River and headpond is a popular pastime for many residents and visitors, and is strongly linked to other activities, such as fishing, waterfowl hunting, and tourism. Common routes travelled by boaters include the area surrounding Mactaquac Provincial Park and coves located along the river (*e.g.*, Wheelers Cove, Jewett's Cove, and Steeple Cove near Kings Landing). A variety of motorized and non-motorized watercraft, including sailboats, ice boats, pontoon boats, and houseboats use the river and headpond.

Recreational fishing in the Lower St. John River and headpond generally focuses on smallmouth bass, trout, and muskellunge (commonly known as muskie). Catch and release fishing for smallmouth bass, an invasive species, in the river system is a popular pastime. Open season for trout fishing within the St. John River extends from April to September, except in lakes, ponds, and reservoirs (such as the headpond) where it is open from May to September (Province of New Brunswick 2022).

Given the level of recreational use in the RAA, and the potential for the environmental effects of the Project to overlap with those of future recreational use, recreational use is carried forward in the cumulative environmental effects assessment.

16.3 IDENTIFICATION OF POTENTIAL CUMULATIVE ENVIRONMENTAL EFFECTS INTERACTIONS

Based on the assessments presented in Chapters 6 to 14, the following eight VCs are anticipated to have residual environmental effects, and a cumulative environmental effects assessment was therefore undertaken:

- Atmospheric environment
- Vegetation and wetlands
- Wildlife and wildlife habitat
- Water resources (surface water only)
- Aquatic environment
- Heritage resources
- Indigenous communities
- Transportation
- Socioeconomic environment

Despite these residual Project effects, interactions between the Project and vegetation and wetlands, wildlife and wildlife habitat, and heritage resources are not anticipated to result in cumulative residual environmental effects with any other project or activity listed in Table 16.1, nor with three broad categories of past, present, or reasonably foreseeable future physical activities, for the following reasons:

- Vegetation and wetlands: Project-related residual environmental effects of the Project on vegetation and wetlands will be limited to the LAA, which encompasses a 30 m buffer of the PDA, and 100 m downstream of the PDA in the St. John River. The only reasonably foreseeable future project or activity which falls within this spatial boundary is the Mactaquac Generating Station AAR Mitigation Project. The AAR Mitigation Project is anticipated to be sited within an existing non-vegetated area within the same PDA as the MLAP and will not result in additional disturbance to vegetation. There is no potential for spatially overlapping cumulative environmental effects to occur with other projects or activities listed in Section 16.2.2. Cumulative environmental effects on vegetation and wetlands are therefore not anticipated and are not discussed further.
- Wildlife and wildlife habitat: Project-related residual environmental effects of the Project on wildlife and wildlife habitat are not anticipated to extend beyond the LAA, which is a 1 km buffer of the PDA. The only reasonably foreseeable future projects or activities which fall within this spatial boundary are the 138 kV Reliability for Fredericton South Project and the AAR Mitigation Project. Both projects are anticipated to be sited within existing non-vegetated or landscaped areas within the same PDA as the MLAP and will not result in additional change to wildlife habitat or wildlife disturbance compared to current conditions. Local disturbance to bird species may occur occasionally, however there is very low potential for spatial or temporal overlap between the residual effects of the MLAP and effects from other projects, given the abundance of habitat in the RAA. There is no potential for spatially overlapping cumulative environmental effects to occur with other projects or activities listed in Section 16.2.2. Cumulative environmental effects on vegetation and wetlands are therefore not anticipated and are not discussed further.

- Heritage resources: An Archaeological Impact Assessment conducted for the PDA identified five Historic Period archaeological sites within the PDA (identified as Borden numbers BlDr-2, BlDr-6, BlDr-8, BlDr-10, and BlDr-12) and there is a sixth Historic Period site whose protective regulatory 100-m buffer zone interacts with the PDA (BlDr-11). All six sites have been registered with the provincial Archaeology and Heritage Branch. In addition to these sites, five areas of elevated potential for sub-surface archaeological resources were identified, including four polygon areas on the north side of the PDA (Polygons KRH-ARCH-030, KRH-ARCH-031, KRH-ARCH-139, and KRH-ARCH-148) and one polygon area on the south side of the PDA (KRH-ARCH-076). Recommendations for additional mitigation (*i.e.*, shovel testing) were made for these five areas in advance of any groundbreaking activities. In addition to the registered sites and polygon areas, the remainder of the PDA is considered to be generally of low archaeological potential. Considering the mitigation that will be implemented for the Project regarding potential heritage resources and since there will be no other projects or activities in the PDA other than the Project which will result in the disturbance of additional areas within the PDA, there is no potential for overlapping cumulative environmental effects to occur with other projects or activities. Cumulative environmental effects on heritage resources are therefore not anticipated and are not discussed further.

As noted previously, environmental effects of past or present projects or activities have already been encompassed in the existing environmental conditions within the RAA for each VC, such that further discussion or assessment of past or present projects or activities is not warranted. Therefore, the residual cumulative environmental effects of the Project in combination with those of other past or present projects or activities on all affected VCs during all phases of the Project are rated not significant and are not discussed further.

Table 16.2 highlights the potential for interactions between the residual environmental effects of the Project and those of the other reasonably foreseeable future projects or activities identified.

Table 16.2 Potential Cumulative Environmental Effects Interactions Among Valued Components and Reasonably Foreseeable Future Projects or Activities

Reasonably Foreseeable Future Project or Activity *	Valued Components					
	Atmospheric Environment	Water Resources	Aquatic Environment	Indigenous Communities	Transportation	Socioeconomic Environment
St. Mary's First Nation Attenuation Pond/Court A Development	-	-	-	-	-	-
Development of Potable Groundwater Source, Riverside Resort and Conference Centre	-	-	-	-	-	-
Mactaquac Generating Station Alkali-Aggregate Reaction Mitigation: Effluent and Sludge Treatment and Disposal (AAR Mitigation Project)	✓	✓	-	✓	-	-

Table 16.2 Potential Cumulative Environmental Effects Interactions Among Valued Components and Reasonably Foreseeable Future Projects or Activities

Reasonably Foreseeable Future Project or Activity *	Valued Components					
	Atmospheric Environment	Water Resources	Aquatic Environment	Indigenous Communities	Transportation	Socioeconomic Environment
Upgrade of On-Site Septic Disposal at Crabbe Mountain Ski Resort	-	-	-	-	-	-
Lincoln Road Infrastructure	-	-	-	-	-	-
Upgrade of On-Site Septic Disposal System at J.D. Irving Deersdale Sawmill	-	-	-	-	-	-
Residential Development in Penniac	-	-	-	-	-	-
Fredericton Landfill Maximum Height Increase Project	-	-	-	-	-	-
Nackawic Marina Development	-	-	-	-	-	-
Groundwater Supply Exploration & Testing, Queen Square Wellfield	-	-	-	-	-	-
McAdam Wellfield Expansion Project	-	-	-	-	-	-
Eradication of Smallmouth Bass in Miramichi	-	-	-	-	-	-
Decommissioning of McAdam Gypsum Wallboard Plant	-	-	-	-	-	-
138 kV Reliability for Fredericton South	-	-	-	-	-	-
Decommissioning of Sewage Treatment Lagoon at Harvey High School	-	-	-	-	-	-
Activities						
Ongoing Interim Operation of MQGS	-	-	✓	✓	-	-
Infrastructure Development and Maintenance	✓	-	-	✓	✓	✓
Recreational Use	-	-	-	✓	-	✓

Notes:
✓ Indicates that the residual environmental effects of the Project on the VC might overlap spatially or temporally with the residual environmental effects of other projects or activities, and therefore a cumulative environmental effects assessment is required.
"-" Indicates potential overlap with the residual environmental effects of other projects or activities is not anticipated, and a cumulative environmental effects assessment is not required.
* Past or present projects or activities have been encompassed in existing environmental conditions for each VC. They are not discussed further.

Those reasonably foreseeable future projects or activities for which no interaction was identified for any VC in Table 16.2 (*i.e.*, those projects or activities identified with a "-" for all VCs) are not carried forward in the cumulative environmental effects assessment, either because they do not overlap spatially or temporally with the environmental effects of the Project, or because of very low magnitude residual environmental effects of the Project or other projects or activities that would result in overall negligible or immeasurable cumulative environmental effects. Further discussion of each of these other future projects or activities for which no interaction was identified with any VC is as follows.

Due to their nature, development of a potable groundwater source at the Riverside Resort and Conference Centre, groundwater supply exploration and testing at the Queen Square Wellfield, and the expansion of the McAdam wellfield are not anticipated to result in residual environmental effects to the atmospheric environment, aquatic environment, transportation, or the socioeconomic environment. Changes to water resources from development of exploration, testing, or development of a groundwater source or supply are anticipated to be mitigated so that changes to groundwater quantities are localized and do not extend to other groundwater users in the vicinity of these projects. No overlapping residual effects to groundwater are anticipated as no residual effects to groundwater have been identified as a result of the MLAP. As there is no spatial overlap between the residual effects of these projects with those of the MLAP, they will not interact cumulatively.

The construction of an attenuation pond and Court A Development at St. Mary's First Nation, Lincoln Road infrastructure upgrades, and the construction of a residential development in Penniac are not anticipated to result in residual effects to transportation or the socioeconomic environment. Residual effects to water resources and the aquatic environment may result from the generation of suspended sediment in the immediate area surrounding these projects. Mitigation measures including the use of sediment and erosion controls, avoidance of watercourses and waterbodies and, development of stormwater management plans are anticipated to limit residual effects of this project to its immediate vicinity and is not anticipated to overlap spatially with the effects of the MLAP. Similarly, changes to the atmospheric environment resulting from air contaminant emissions are anticipated to be localized and not overlap spatially with the MLAP. As there is no spatial overlap between the residual effects of this project with those of the MLAP, they will not interact cumulatively.

Development at the Nackawic Marina is anticipated to result in positive effects to the socioeconomic environment through improved access to boating and recreation activities resulting from improved marina facilities. Residual effects to water resources and the aquatic environment may result from the generation of suspended sediment in the immediate area surrounding the marina project, and the physical footprint of in-water structures. Mitigation measures such as the use of turbidity curtains are anticipated to limit residual effects of this project to its immediate vicinity, and its effects are not anticipated to overlap spatially with the effects of the MLAP. Similarly, changes to the atmospheric environment resulting from air emissions are anticipated to be localized and not overlap spatially with the MLAP. As there is no spatial overlap between the residual effects of this project with those of the MLAP, they will not interact cumulatively.

The upgrades of on-site septic disposal at Crabbe Mountain Ski Resort and at the J.D. Irving Deersdale sawmill are not anticipated to result in residual environmental effects to the atmospheric environment, the aquatic environment, transportation, or the socioeconomic environment. Changes to water resources from upgrades to on-site septic systems are anticipated to be fully mitigated so there are no changes to groundwater quality for users in the vicinity of projects. As there is no spatial overlap between the residual effects of these projects with those of the MLAP, they will not interact cumulatively.

Decommissioning of the McAdam Gypsum Wallboard Plant and the sewage treatment lagoon at Harvey High School are not anticipated to result in residual environmental effects to water resources, the aquatic environment, transportation, or the socioeconomic environment. These projects will likely result in the generation of dust and other air emissions; however, with mitigation, these emissions are anticipated to be localized and are unlikely to extend to the area surrounding the MLAP given the distance between the projects (approximately 28 and 53 km, respectively). As there is no spatial overlap between the residual effects of these projects with those of the MLAP, they will not interact cumulatively.

The eradication of smallmouth bass in the Miramichi watershed is anticipated to result in residual effects to the aquatic environment. However, these residual effects will be limited to the Miramichi watershed and are not anticipated to overlap spatially with the aquatic environment in the St. John River watershed. As there is no spatial overlap between the residual effects of this project with the MLAP, they will not interact cumulatively.

The 138 kV Reliability for Fredericton South project consists of construction and operation of a 16.1 km-long, 138 kV transmission line between the Rainsford Substation in Fredericton and the Mactaquac Terminal near the Mactaquac Generation Station. The planned construction completion date of this project is 2024, with an in-service date in 2025. As construction has been completed, there is no temporal overlap with the residual effects of the construction of this project with the MLAP. The residual effects resulting from the operation of the transmission line are anticipated to be similar to other transmission lines that are currently operating in the vicinity of the project, and to be localized and minimal; therefore they are not anticipated to overlap with the residual effects of the MLAP.

A temporary or extended closure of Mactaquac Road due to the Project would result in detours of 10 to 20 minutes or more. The majority of traffic is expected to detour via the Westmorland Street Bridge during a closure of Mactaquac Road (exp 2022), resulting in increases in traffic levels along the detour route including two key intersections at Route 105 (Ring Road) and Brookside Drive, and Route 105 (Ring Road) and Maple Street. Although it has not been registered yet, planned construction on the Mactaquac Road bridge to be conducted by NBDTI is a major Infrastructure Development and Maintenance project that has been announced publicly, and this will also result in traffic delays, lane closures, and potential detours in this area. However, this work is anticipated to be completed in 2023 before the construction of the MLAP begins; therefore, there is no temporal overlap between this activity and the Project, and residual effects will not interact cumulatively.

For other future projects or activities listed in Table 16.2 for which an interaction with the effects of the Project is not anticipated, the residual cumulative environmental effects of the Project in combination with those of other future projects or activities on all affected VCs during all phases of the Project are rated not significant and are not discussed further.

16.4 ASSESSMENT OF CUMULATIVE ENVIRONMENTAL EFFECTS

Reasonably foreseeable future projects or activities that have been identified in Table 16.2 as having potentially overlapping environmental effects with those of the Project, for one or more VCs, have been carried forward in the cumulative environmental effects assessment. Those include the following reasonably foreseeable future projects or activities:

- The AAR Mitigation Project
- Ongoing interim operation of the MQGS
- Infrastructure development and maintenance
- Recreational use

Those potential cumulative environmental effects are assessed below, by VC.

16.4.1 Cumulative Environmental Effects on Atmospheric Environment

16.4.1.1 Summary of Project Residual Effects

As described in Section 6.2.5, Project-related releases of air contaminants (*e.g.*, combustion gases and dust) are not expected to exceed provincial or federal air quality objectives or standards during construction. The release of air contaminants during construction is not expected to be substantive or contribute measurably to existing ambient levels as they are projected to be moderate in magnitude beyond the PDA. Greenhouse gas emissions (GHG) emissions during Project construction are estimated to be small in comparison to other industrial sources of GHG emissions in New Brunswick and would result in approximately 10,000 to 15,000 tonnes (t) of carbon dioxide (CO_2) equivalent (e) (tCO_2e) per year, depending on the length of the construction period. With mitigation measures employed, the release of GHG emissions during construction is expected to be moderate in magnitude. Construction noise generated by the Project is anticipated to be typically intermittent, fluctuating during active construction, and will generally be confined to the LAA and during daytime hours only. Existing nighttime sound pressure levels are not expected to be affected as construction is planned to be limited to daytime hours, to the extent feasible.

The continued operation and maintenance of the MQGS following construction will continue to provide non-emitting, renewable electricity to the New Brunswick electrical grid that could otherwise be generated by emitting sources (*e.g.*, fossil fuels), no substantial emissions of air contaminants or GHGs are expected to occur during operation and maintenance of the Project.

16.4.1.2 Cumulative Environmental Effects

Table 16.2 identified a potential for the Project to cause cumulative environmental effects to the atmospheric environment in combination with the following reasonably foreseeable future projects or activities:

- AAR Mitigation Project
- Infrastructure development and maintenance

Although other reasonably foreseeable future projects or activities may also release emissions of air contaminants to the environment, their contribution to the airshed in combination with those of the Project are unlikely to result in an exceedance of ambient air quality standards or objectives locally or within the RAA. It is also unlikely that these future activities would occur in the LAA for atmospheric environment during the construction phase of the Project, except for the MQGS AAR Mitigation Project.

The construction of the AAR Mitigation Project and local infrastructure development and maintenance along Mactaquac Road (including repairs to the NBDTI owned bridge) will overlap spatially and temporally with the MLAP. However, both of these projects are much smaller in magnitude than the MLAP and similar mitigation measures will be implemented to reduce the release of air contaminants and noise. Emissions and from the MLAP acting cumulatively with the air contaminant emissions of the AAR Mitigation Project and infrastructure development and maintenance activities are unlikely to result in an exceedance of ambient air quality standards or objectives. Similarly, noise created by the AAR Mitigation Project and infrastructure development and maintenance activities along Mactaquac Road is anticipated to be very small in magnitude and is not anticipated to represent a substantive increase in ambient noise levels during construction of the MLAP.

Because of the relatively small footprint and duration of construction, Project-related releases of GHGs during construction will not measurably contribute to provincial and national GHG totals.

Considering the above, overlapping cumulative environmental effects on the atmospheric environment during Project construction and operation and maintenance are not anticipated. Other future projects or activities would be subject to approvals and permits which would determine the acceptability of their environmental effects and prescribe any required mitigation. Therefore, the residual cumulative environmental effects of the Project in combination with those of other reasonably foreseeable future projects or activities (including the AAR Mitigation Project as well as Infrastructure Development and Maintenance) on the atmospheric environment during all phases of the Project are rated not significant.

16.4.2 Cumulative Environmental Effects on Water Resources

16.4.2.1 Summary of Project Residual Effects

The residual environmental effects of construction of the Project on water resources are predicted to be adverse in direction as there will be a change in timing of surface water flow regimes during construction and a potential change in surface water quality and quantity as a result. Overall, the magnitude of residual environmental effects is predicted to be low as water quality parameters are anticipated to remain near baseline levels, and daily water levels are expected to remain within normal operating range. These changes will be primarily within the LAA. The duration of environmental effects on water resources will extend throughout the construction phase.

Operation and maintenance activities associated with the MQGS are not expected result in changes to water resources.

16.4.2.2 Cumulative Environmental Effects

During construction, past and present projects and activities in the RAA are expected to be ongoing and similar to past and present activities in terms of contribution to changes to surface water flow and surface water quality; those environmental effects are encompassed in existing conditions for water resources (Section 9.4).

Table 16.2 identified a potential for the Project to cause cumulative environmental effects on water resources in combination with the following reasonably foreseeable future project or activity:

- AAR Mitigation Project

The operation of the AAR Mitigation Project is anticipated to result in the release of treated water to the St. John River which may result in a change in surface water flow or quality. However, as the AAR Mitigation Project is located on the MQGS property, and will be constructed and operated by NB Power, it is anticipated that the same treatment facility will be used for both the AAR Mitigation Project and the MLAP. As a result, the physical and chemical characteristics of the effluent discharged from the treatment facility will be the same for both projects, and NB Power will continue to meet water quality discharge limits for these activities. The total volume of treated effluent from both projects is anticipated to be negligible in comparison to the overall flow rate of the St. John River. Therefore, the residual cumulative environmental effects of the Project in combination with those of other future projects or activities on water resources during all phases of the Project are rated not significant.

Therefore, the residual cumulative environmental effects of the Project in combination with those of other reasonably foreseeable future projects or activities (including the AAR Mitigation Project) on the atmospheric environment during all phases of the Project are rated not significant.

16.4.3 Cumulative Environmental Effects on the Aquatic Environment

16.4.3.1 Summary of Project Residual Effects

The residual effects of construction of the Project on the aquatic environment will include changes to fish habitat quantity due to in-water works, which will be adverse in direction, low in magnitude, and occur within the PDA, and changes to fish health and survival because of fish passage, which will be adverse in direction, low in magnitude, and occur within the PDA. Residual changes to fish habitat quality are not anticipated.

Operation and maintenance of the Project will result in positive changes to fish habitat quantity and primarily positive changes to fish health and survival due to improved fish passage.

16.4.3.2 Cumulative Environmental Effects

Table 16.2 identified a potential for the Project to cause cumulative environmental effects on the aquatic environment in combination with the following reasonably foreseeable future project or activity:

- Ongoing Interim Operation of the MQGS.

The development and construction of the MQGS over 50 years ago permanently changed the aquatic habitat in the St. John River. These substantial changes have contributed to the existing aquatic environment in which the Project will occur. The effects of the Project on the aquatic environment will interact cumulatively with the effects of the development and construction of the MQGS that persist today. Because the existing aquatic environment includes the effects of the original construction of the MQGS, the cumulative environmental effects of the Project in combination with those of the construction of the MQGS are inherently considered in the assessment of Project effects (Section 10). The Project's contribution to these cumulative adverse effects on the aquatic environment is small, and in some cases positive (*e.g.*, improvements to fish passage).

The ongoing interim operation of the MQGS while construction is taking place for the Project results in adverse changes to fish health and survival as a result of impingement and entrainment within water intakes and the powerhouse. During Project construction, in-water works will be conducted in respect of the DFO timing windows, to the extent practicable, which will protect fish and reduce the potential for direct mortality of fish larvae or eggs. Fish rescue activities will be completed in areas that will be isolated from the St. John River prior to in-water works to the extent practicable. Both the Project and ongoing operation of the MQGS will follow DFO guidance for mitigation and will obtain authorization under the *Fisheries Act,* if and as required. Considering this mitigation (which will be implemented both by the Project and by the ongoing operation of the MQGS), the residual cumulative environmental effects of the Project in combination with those of other reasonably foreseeable future projects or activities (including the ongoing interim operation of the MQGS) on the aquatic environment will be managed to applicable regulatory standards during all phases and are therefore rated not significant.

16.4.4 Cumulative Environmental Effects on Indigenous Communities

As described in Section 12, the creation of the headpond caused substantial changes to plant and animal populations, and contributed to the alteration of the culture of Indigenous communities in New Brunswick.

During construction, access to the MQGS property will be controlled for safety and security, and access through the property for fishing by Indigenous people will not be available during this time but will likely resume following construction. Similarly, if traditional plants are being collected on the MQGS property, access will be limited during construction. As noted in Section 12, substantive changes to traditionally harvested resources are not anticipated.

Table 16.2 identified a potential for the Project to cause cumulative environmental effects to Indigenous communities in combination with the following reasonably foreseeable future projects or activities:

- AAR Mitigation Project
- Ongoing Interim Operation of MQGS
- Infrastructure Development and Maintenance
- Recreational Use

These other future projects and activities can alter access to resources used by Indigenous communities, the effects of which may act cumulatively with the effects of the Project, further reducing access to resources. Restrictions in access resulting from the Project will be limited to the construction phase.

NB Power is committed to providing meaningful opportunities for ongoing dialogue about the Project with Indigenous communities. Consultation and engagement that has occurred to date and will continue throughout the Project is described in Section 4. As Project planning and design continues and throughout the execution of the Project, NB Power is committed to ongoing consultation and engagement with Indigenous communities.

Over the remaining life of the MQGS, NB Power will consult and engage with Indigenous communities to identify opportunities for benefits and accommodation. A capacity funding agreement has been established between the Wolostoqey and NB Power, which was developed collaboratively to guide ongoing engagement and to foster a meaningful and productive dialogue. This agreement outlines a process to develop accommodation if and as required to adverse effects that cannot be mitigated.

16.4.5 Cumulative Environmental Effects on Transportation

16.4.5.1 Summary of Project Residual Effects

Travel delays and detours are expected for Project-related closures of Mactaquac Road intermittently throughout construction, but they will not result in a drop below Level of Service (LOS) D (satisfactory) for key intersections. One intersection is currently operating at LOS F (unacceptable), and this is expected to continue during closures of Mactaquac Road. Oversized or overweight Project vehicles will only operate if NBDTI has issued a relevant permit, with associated conditions to protect the integrity of the road infrastructure.

With the implementation of mitigation measures as described herein, the residual adverse environmental effects of the Project on transportation will be not result in a drop in the existing LOS of the road network below LOS D (for roads and intersections that were otherwise classified as LOS A, B, or C, nor will they degrade or damage road network infrastructure such that it cannot function at the current level of service.

Project vehicles will comply with size and weight restrictions that may be applicable for existing roadways. If oversized vehicles are required, NB Power will work with NBDTI to obtain necessary permits and approvals and will comply with any conditions of these approvals.

No Project-related changes to transportation during operation and maintenance are anticipated. Following construction, transportation is expected to return to baseline conditions. Therefore, there are no residual effects of the Project on transportation during operation and maintenance.

16.4.5.2 Cumulative Environmental Effects

Table 16.2 identified a potential for the Project to cause cumulative environmental effects to the socioeconomic environment in combination with the following reasonably foreseeable future projects or activities:

- Infrastructure development and maintenance

Adverse residual effects of the Project on the transportation include a moderate change in transportation resulting periodic closures of Mactaquac Road during construction. It is anticipated that future infrastructure development and maintenance activities, and specifically further repairs to the NBDTI owned bridge which crosses the intake channel will also result in disruptions to traffic which may interact cumulatively resulting in longer durations of disruptions. It is anticipated that closures will be communicated to local residents and detour routes will be identified to allow planning for potential delays. These closures will also be communicated to local emergency response organizations so that alternative routes can be identified which maintain expected response times.

While there may be occasional short-term overlapping environmental effects of the Project and infrastructure development and maintenance activities, with mitigation applied, it is unlikely that those overlapping environmental effects would result in a drop in the existing LOS of the road network below LOS D for roads and intersections that were otherwise classified as LOS A, B, or C, except for intermittent or short periods of time not exceeding one month.

Weight restrictions will be respected and necessary permits for overweight or oversize loads will be obtained for both the MLAP and infrastructure development and maintenance activities. Therefore, degradation of road network infrastructure so that it cannot function at the current level of service and/or results in damage to the infrastructure that is substantive is not anticipated.

No residual effects of the Project on transportation during operation and maintenance have been predicted, therefore there are no cumulative effects anticipated during operation.

The residual cumulative environmental effects of the Project in combination with those of other reasonably foreseeable future activities (including Infrastructure Development and Maintenance as well as Recreational use) on the transportation during all phases of the Project are rated not significant.

16.4.6 Cumulative Environmental Effects on the Socioeconomic Environment

16.4.6.1 Summary of Project Residual Effects

During construction, access to the MQGS property will be controlled for safety and security. Other changes to access or recreational opportunities are not anticipated. NB Power will communicate the Project schedule including planned road closures in advance to the public and surrounding communities. This will allow the public and emergency response organizations time to prepare for the closure, and potentially reposition resources so that they can continue to meet their expected response times.

Changes in employment and the economy are expected to be positive since the Project will create employment and contracting opportunities for the construction period. Construction of the Project could result in some limited competition for labour in specialized trades; however, local residents, communities, and businesses will be informed of job opportunities and Project purchasing requirements in advance. Project-related expenditures will result in direct, indirect, and induced employment in the LAA, with increased spending for goods and services in the LAA by Project workers temporarily brought to the region to work on the Project.

16.4.6.2 Cumulative Environmental Effects

Table 16.2 identified a potential for the Project to cause cumulative environmental effects to the socioeconomic environment in combination with the following reasonably foreseeable future projects or activities:

- Infrastructure Development and Maintenance
- Recreational Use

Adverse residual effects of the Project on the socioeconomic environment include a small change in recreational opportunities in the St. John River (*e.g.*, recreational fishing) resulting from the restrictions in access to the PDA during construction. Reasonably foreseeable future projects or activities are not anticipated to result in an additional loss of access to recreational opportunities within the RAA. It is anticipated that future infrastructure development and maintenance activities which may result in disruptions to traffic will also be communicated to local emergency response organizations so that alternative routes can be identified which maintain expected response times.

Other reasonably foreseeable projects or activities (including Infrastructure Development and Maintenance initiatives) will have the potential to affect labour and economy in New Brunswick in a similar way to the MLAP. The combined increase in demand for labour and accommodation of the Project and these activities is not expected to exceed the capacity of the labour market or available accommodations. Positive effects of the Project related to employment and expenditures and those of reasonably foreseeable future projects are anticipated to result in a net positive cumulative effect.

In summary, while there may be occasional short-term overlapping environmental effects of the Project with those of other projects or activities that have been or would be carried out, given the nature of the Project and RAA, it is unlikely that those overlapping environmental effects would cause a significant cumulative environmental effect. Therefore, the residual cumulative environmental effects of the Project in combination with those of other reasonably foreseeable future activities (including Infrastructure Development and Maintenance as well as Recreational use) on the socioeconomic environment during all phases of the Project are rated not significant.

16.5 SUMMARY AND DETERMINATION OF SIGNIFICANCE

Overall, the PDA for the Project is relatively small and confined to largely already-disturbed areas in a location with limited other development, which reduces residual Project and cumulative environmental effects. The existing MQGS and associated facilities, as well as past and present projects or activities, have affected (or continue to affect) the existing landscape that was considered in the baseline conditions used to assess the residual environmental effects of the Project.

The Project will result in some environmental effects on VCs that may potentially overlap with similar environmental effects on those VCs from other past, present, or reasonably foreseeable projects or activities in the area. However, in all cases, these residual cumulative environmental effects are similar to the residual Project environmental effects presented in the EIA registration document, with limited temporal or spatial overlap. Residual environmental effects from Project activities are predicted to be not significant. It is understood that other projects or activities defined as undertakings in the EIA Regulation or under review by other regulatory processes will also be required to reduce potential environmental effects through compliance with government standards and permit stipulations, further reducing the potential for cumulative environmental effects. No additional mitigation is recommended to address cumulative effects. It is expected that the Project will contribute to regional and provincial economic benefits that will overlap with economic activity created by other undertakings at regional and provincial levels.

Given the limited residual environmental effects of the Project and planned mitigation, overall, the residual cumulative environmental effects of the Project in combination with other past, present, or reasonably foreseeable projects or activities that have been or will be carried out during all phases of the Project on all affected VCs are rated not significant, with a high level of confidence.

There is no follow-up proposed to verify the cumulative environmental effects predictions.

16.6 REFERENCES

CEAA (Canadian Environmental Assessment Agency). 2014. Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012. Available from: https://www.canada.ca/en/environmental-assessment-agency/services/ policy-guidance/technical-guidance-assessing-cumulative-environmental-effects-under-canadian-environmental-assessment-act-2012.html.

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17.0 ACCIDENTS, MALFUNCTIONS, AND UNPLANNED EVENTS

Accidents, malfunctions, and unplanned events refer to events or conditions that are not part of any activity or normal operation of the Project as planned by NB Power. Even with the best planning and the implementation of preventative measures, the potential exists for accidents, malfunctions, or unplanned events to occur during any Project phase, and if they occur, for adverse environmental effects to result if these events are not addressed or responded to in an environmentally appropriate manner. Many accidents, malfunctions, and unplanned events are preventable and can be readily addressed or prevented by good planning, design, emergency response planning, and mitigation. By identifying and assessing the potential for these events to occur, NB Power can also identify and put in place prevention and response procedures to reduce or eliminate the potential for significant adverse environmental effects, should an accidental event occur.

As was described in Chapter 2, the Project is being designed, and will be constructed and operated, according to best practices for health, safety, and environmental protection to reduce the potential environmental effects that could result from the Project, as well as those that could result from accidents, malfunctions, or unplanned events. Prevention and mitigation will be accomplished by the following general principles.

- Use best management practices and technology for carrying out the Project.
- Incorporate safety and reliability by design, and application of principles and practices of process and dam safety management.
- Develop and apply procedures and training aimed at safe operation of the facilities that prevent or avoid the potential upsets that might lead to accidents, malfunctions, or unplanned events.
- Implement effective emergency preparedness and response, including development of applicable contingency plans.

Potential accidents, malfunctions, and unplanned events that could reasonably occur during any phase of the Project and result in adverse environmental effects are described and assessed in this section. The focus of the assessment is on credible accidents or scenarios that, although unlikely, could result in substantive adverse residual environmental effects. Credible accidents and scenarios were identified based on knowledge of the Project, and experience with other similar projects and activities.

17.1 ENVIRONMENTAL PROTECTION PLAN

An Environmental Protection Plan (EPP) will be developed for the Project. The purpose of the EPP is to document and describe the environmental protection measures to be implemented by Project personnel to prevent or reduce potential adverse environmental effects from Project activities in compliance with regulatory requirements. The EPP also identifies the steps to be taken in response to an unplanned or emergency environmental situation.

A Project-specific Environmental Management Plan (PSEMP) will also be developed as part of the mitigation planning in the EPP. The PSEMP will include waste management procedures for solid and hazardous wastes, as well as best management practices for reducing volumes of wastes and concentrations of contaminants entering the environment.

17.2 APPROACH

This discussion of the potential environment effects of accidents, malfunctions, or unplanned events includes:

- Consideration of the potential events that could occur during the life of the Project
- Description of the Project planning and safeguards established to reduce the potential for such occurrences to happen, and during which phase(s) or activity(ies)
- Determining with which valued component(s) (VCs) the potential accident, malfunction, or unplanned event may interact
- Describing the Project planning, mitigation, and safeguards established to minimize the potential for such occurrences to happen
- Consideration of the contingency or emergency response procedures applicable to the event
- Determination of the potential residual environmental effects on related VCs in the unlikely event that these accidents, malfunctions, or unplanned events do happen, and determining the significance of the potential residual environmental effects of these accidents, malfunctions, or unplanned events (and their likelihood of occurrence, as applicable).

Spatial and temporal boundaries for considering residual environmental effects of potential accidents, malfunctions, and unplanned events that may arise as a result of the Project are the same as those for each VC to which they apply, presented earlier in this document. Similarly, criteria used for determining the significance of residual environmental effects with respect to potential accidents, malfunctions, and unplanned events are the same as those for each applicable VC.

17.3 IDENTIFICATION OF CREDIBLE ACCIDENTS, MALFUNCTIONS, OR UNPLANNED EVENTS

Various scenarios were identified for consideration in the section. As a first step, it was considered if a scenario is credible. Rationale is provided for scenarios not considered to be credible and those are not discussed further in the assessment. Environmental effects of credible accidents, malfunctions, or unplanned events on each applicable valued component (VC) were described.

The potential accidents, malfunctions, and unplanned events that were identified for consideration are:

- Discovery of heritage resource
- Disturbance of a bird nest
- Stranding fish
- Alkali aggregate reaction (AAR)
- Failure of erosion and sedimentation control
- Loss of structural integrity

- Fire
- Hazardous material spill
- Vehicle accident
- Cofferdam failure

17.3.1 Determination of Credible Scenarios

17.3.1.1 Discovery of Heritage Resource

Discovery of a previously unidentified heritage resource during construction has been considered.

Archaeological impact assessments (AIA) conducted for the PDA identified two archaeological sites within the PDA (BlDr-2 and BlDr-6) that have now been registered with the Archaeology and Heritage Branch (AHB) of the New Brunswick Department of Tourism, Heritage and Culture. The remainder of the PDA has been considered to be generally of low archaeological potential. Any sections evaluated to be at an elevated potential for heritage resource discovery were indicated on mapping (polygons) to guide construction activities. Planned avoidance of the registered sites BIDr-2 and BIDr-6, their 100 m buffer zones, and polygons will occur.

Due to the completed AIAs, marking of registered archaeological sites and polygons, and planned avoidance of these sites, a discovery of previously unidentified heritage resource during construction is unlikely to occur and is not considered a credible scenario. NB Power has a heritage resources discovery contingency plan in place in the unlikely event that a previously unknown resources is encountered.

17.3.1.2 Disturbance of a Bird Nest

Disturbance of a bird nest would be characterized by a migratory bird nest being discovered and moved, damaged, or otherwise disturbed during construction.

The construction phase of the Project will use previously disturbed areas for Project infrastructure and workspaces to the extent practicable.

If vegetation clearing is necessary, it will be completed outside the migratory bird nesting period of April 12 to August 27 (Zone C3; ECCC 2018). Where activities may result in risk of harm to migratory bird nests during this period (*e.g.*, limited vegetation clearing, construction on disturbed areas that could be used by ground-nesting birds, nesting on Project infrastructure) or during the nesting period for other species (*i.e.*, raptors), a qualified biologist will complete a pre-activity nest survey in accordance with federal guidelines (ECCC 2022).

If an active bird nest is found, beneficial management practices will be followed, including applying an appropriate setback and timing restriction, and NB Fish & Wildlife and/or Canadian Wildlife Service (CWS) will be consulted, as appropriate.

With these mitigation measures in place, it is unlikely that a migratory bird nest would be disturbed during the Project and is not a credible scenario.

17.3.1.3 Stranding Fish

Stranding fish would be characterized by fish being trapped in an area that has been dewatered for work, such as a cofferdam. A fish in this scenario would be unable to continue its passage through the MQGS and would not be able to carry out its lifecycle. If a fish remains trapped in an enclosure for a substantive period of time, injury or mortality could occur.

Any area to be dewatered for Project-related construction work, such as cofferdams, will follow relevant standards and practices. Part of these practices includes fish rescues, in which any fish trapped in the dewatering area following construction of the perimeter are removed and returned to the water outside of the work area. Only once any contained fish have been rescued and removed will the work area be completely dewatered.

With standard mitigation practices in place, including conducting fish rescue operations in the impounded areas prior to their dewatering, it is unlikely that fish would be trapped in a dewatered area for a substantive period of time such that injury or mortality could occur. Therefore, this is not a credible scenario.

17.3.1.4 Alkali Aggregate Reaction (AAR)

AAR would be characterized by new or exacerbated occurrences of this specific chemical reaction in the concrete used to refurbish certain components of MQGS.

NB Power will obtain aggregate from sources that are known to not result in AAR and will test aggregate materials prior to construction to determine the material is appropriate for use in the main spillway, diversion sluiceway, water intake structure, and powerhouse. All concrete will be manufactured by off-site approved concrete ready-mix plants bringing concrete to the MQGS site, and at this time there is no anticipated need for an on-site concrete plant for the Project. Aggregates used by the concrete ready-mix plants will be sourced from off-site borrow sources.

As for existing concrete that will remain following construction, the purpose of the Project is to remediate the concrete structures so that AAR does not continue to affect the operation of the refurbished MQGS. With the planned materials testing and remediation, it is unlikely that AAR will occur following refurbishment of affected MQGS components and is therefore not considered a credible scenario.

17.3.1.5 Failure of Erosion and Sedimentation Control

Project-related erosion and sedimentation control devices that will be implemented as key mitigation to avoid or reduce environmental effects due to erosion and sedimentation during construction of the Project. This scenario is considered credible for the Project and is assessed in section 17.4.

17.3.1.6 Loss of Structural Integrity

Loss of structural integrity would be characterized by a failure of one or more components of the MQGS such that containment of the headpond may be at risk.

The earthen dam of the MQGS remains structurally viable and unaffected by AAR. It is important to note that the Project is being designed to address components of the MQGS that are being affected by AAR so that they do not result in potential future structural concerns. The refurbishment of Project components will be completed to modern Canadian Dam Association (CDA) standards, including dam inspections completed every three years following completion. Various probable maximum flood studies have been conducted to understand possible failure modes, and CDA inspections will occur as necessary throughout construction and operation to prevent failure. A complete failure of MQGS components that would result in a loss of containment is considered to be an extremely low probability event.

With the purpose of the Project being such that structural integrity of the MQGS is maintained or improved through refurbishment, along with CDA guidelines and inspections in place, this scenario is not considered to be credible.

17.3.1.7 Fire

There is potential that a fire could occur because of Project activities. A fire affecting Project components would likely involve Project infrastructure, a vehicle, or other heavy equipment used during construction or operation and maintenance activities. It is also possible that Project-related machinery could ignite a fire of nearby combustible materials (*e.g.*, grass, brush, trees). This is considered a credible scenario and is assessed in section 17.4.

17.3.1.8 Hazardous Material Spill

A spill of hazardous material can occur in any environment where fuels, lubricants, hydraulic fluid, paints, and corrosion and fouling inhibitors are used or stored. Hazardous materials may be used during construction, and operation and maintenance of the Project. A spill of hazardous materials could result from equipment spills, spills from vehicles, an on-site trucking accident, or tank leak or rupture that occurs within the PDA, with vehicles being the most common source of hazardous materials on-site. Potential scenarios involving the release of hazardous material would most likely be a spill from refueling activities. A hazardous material spill is considered a credible scenario for the Project and is assessed in section 17.4.

17.3.1.9 Vehicle Accident

During the construction and operation and maintenance of the Project, various vehicles will be in motion around the Project site and there is the potential for a vehicle collision to occur, including a vehicle-to-vehicle collision, vehicle-to-pedestrian collision, or vehicle collision with surrounding private property, Project infrastructure, or wildlife. This scenario is considered credible for the Project and is assessed in section 17.4.

17.3.1.10 Cofferdam Failure

Cofferdams will be used during Project construction to complete work in the dry in the St. John River. The construction of cofferdams permits work to be carried out in the dry without restricting normal flow of the river. There is the potential for cofferdam failure to occur during construction, particularly if cofferdams are left in place for long periods of time, including throughout changes in seasons which may affect water flow surrounding the cofferdams. This is a credible scenario for the Project and is assessed in section 17.4.

17.4 POTENTIAL INTERACTIONS BETWEEN ACCIDENTS, MALFUNCTIONS, AND UNPLANNED EVENTS AND RELATED VALUED COMPONENTS

Based on the nature of the above credible events and the study team's knowledge of their potential to interact with the environment, the VCs with a reasonable potential to interact with these potential accidents, malfunctions, or unplanned events that could result in residual environmental effects are identified in Table 17.1.

Table 17.1 Potential Interactions of Accidents, Malfunctions, and Unplanned Events with Value Components

Accident, Malfunction, or Unplanned Event	Atmospheric Environment	Vegetation and Wetlands	Wildlife and Wildlife Habitat	Water Resources	Fish and Fish Habitat	Heritage Resources	Indigenous Communities Environment	Transportation	Socioeconomic Environment
Failure of Erosion and Sediment Control Measures	-	✓	-	✓	✓	-	-	-	-
Fire	✓	-	✓	-	-	-	✓	-	✓
Hazardous Material Spill	✓	-	✓	✓	✓	-	✓	-	✓
Vehicle Accident	-	-	✓	-	-	-	-	✓	-
Cofferdam Failure	-	-	-	✓	✓	-	-	-	-
Notes ✓ indicates a potential interaction - indicates no interaction									

Those accidents, malfunctions, or unplanned events that may result in an interaction with a specific VC are identified with a checkmark in the table above, and are therefore carried for further assessment below.

Accidents, malfunctions, or unplanned events that are not identified with a checkmark in the table above are not expected to result in an interaction with a specific VC or VCs. For those accidents, malfunctions, or unplanned events, there are no residual environmental effects of the Project with the VCs for which an interaction was not identified in the above table.

17.5 ASSESSMENT OF CREDIBLE ACCIDENTS, MALFUNCTIONS, AND UNPLANNED EVENTS

The following credible accidents, malfunctions, and unplanned events have been selected for consideration in this assessment and are discussed in the following sections.

17.5.1 Failure of Erosion and Sedimentation Control

A failure of erosion and sedimentation control could release sediment-laden water to the St. John River. Such a failure could adversely affect riparian vegetation, surface water quality, and the aquatic environment. Sedimentation of riparian vegetation, and changes to water quality, including fish habitat, could occur. Changes to fish habitat could include reduced water quality due to increased sediment. Sediment reaching the bottom of the watercourse could adversely affect fish eggs, if present, or benthic organisms.

17.5.1.1 Risk Management and Mitigation

The following mitigation measures will be applied to reduce the likelihood of a failure of erosion and sedimentation control:

- An Environmental Management Plan that includes a site-wide sedimentation and erosion protection plan will be implemented for the Project.
- Natural regeneration of disturbed areas will be allowed when the risk of erosion is deemed low.
- Walkover inspections of work areas will occur in advance of severe weather events to visually observe that all sedimentation and erosion control protections are in place.
- Inspections will occur following severe weather events to reduce the risk of sedimentation and erosion control failure.
- If erosion risk in particular areas is deemed to be high and reseeding is considered warranted, the vegetation in the undisturbed surrounding area will be considered prior to selecting an appropriate seed mix for the site.

17.5.1.2 Potential Residual Environmental Effects

Erosion and sedimentation control is a routine and well-understood mitigation measure that is used on a variety of construction sites. With frequent inspections and monitoring of the controls, and conducting maintenance as required, a failure of erosion and sedimentation control is not likely to occur.

As such, with the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a failure of erosion and sedimentation control on water resources, the aquatic environment, and vegetation during all phases of the Project are rated not significant.

17.5.2 Fire

A fire could release emissions to the atmosphere, affect infrastructure adjacent to the PDA, endanger lives or result in loss of life for humans and biota, and affect the ability of Indigenous persons and the public to use areas surrounding the PDA.

If uncontrolled, a fire could also affect vegetation, wildlife, and wildlife habitat in forested areas surrounding the PDA. Naturally occurring forest fires that could potentially affect the Project are assessed as an effect of the environment on the Project (Chapter 15).

17.5.2.1 Risk Management and Mitigation

The following risk management and mitigation measures will be applied to reduce the probability of a fire and associated adverse effects:

- Vehicles on-site will be equipped with fire extinguishers that are sized and rated as fit for purpose.
- Project infrastructure will have strategically positioned heat and smoke detectors and alarms, as well as automatic sprinklers and extinguishers as applicable.
- Project infrastructure will be equipped with sensors and emergency shut off controls as appropriate.
- Project staff will be trained in the use of fire extinguishers and related fire suppression equipment and procedures and will be familiar with the location of the nearest extinguisher and associated supplies.
- Vehicles will avoid parking in areas with long grass to reduce the risk of fire caused by the heated vehicle undercarriage, and vehicles will not be allowed to idle when not in use.
- Smoking will only be permitted in designated areas equipped with proper butt disposal receptacles.
- Debris from clearing activities will be managed and disposed of to reduce risk of fire and the magnitude of the fire, should one occur.
- Flammable materials will be stored in appropriate containers in designated storage areas.
- Waste that may be soaked with flammable or explosive materials (*e.g.*, oily rags) will be stored in appropriate containers, kept away from flammable materials, and disposed of in an acceptable manner as soon as possible.

In the unlikely event that a fire does occur, potential environmental effects will be reduced by following an emergency response and contingency plan that will be part of the Project-specific EPP, which will include procedures for:

- Response protocols with emergency departments
- Reducing the spread of fire
- Evacuation planning including route identification and muster locations

17.5.2.2 Potential Residual Environmental Effects

If fire were to occur, there is potential for a temporary decrease in air quality arising from the smoke that is generated. There is also potential for a fire to result in loss of or damage to infrastructure or equipment, and restricted access to the area.

As the PDA will be virtually cleared of vegetation, if a fire were to occur it is expected to be small and easily extinguished, resulting in minimal smoke generation and damage to infrastructure. In the unlikely event that a fire was widespread, there is potential to result in wildlife species at risk mortality or destruction of wildlife species at risk habitats, vegetation, and wetlands. There is also potential for damage to infrastructure on nearby properties. However, with planned mitigation and response procedures, the occurrence of a widespread fire that affects species at risk, or nearby properties is unlikely.

Thus, in the unlikely event of a fire, and in consideration of the mitigation to be implemented, and the response measures to be undertaken, the residual adverse environmental effects during all phases of the Project are not anticipated to be substantive. As such, with the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a fire on the atmospheric environment, vegetation, wildlife and wildlife habitat, the socioeconomic environment, and Indigenous communities during all phases of the Project are rated not significant.

17.5.3 Hazardous Material Spill

A large hazardous material spill may affect the quality of surface and groundwater, fish and fish habitat, and wetland habitat, and result in the ingestion/uptake of contaminants by wildlife and subsequently limit the ability of these resources to be used by Indigenous persons and by the public. If the spill is volatile, it may affect the atmospheric environment.

17.5.3.1 Risk Management and Mitigation

The following mitigation measures will be applied to reduce the likelihood of a spill:

- Routine preventative maintenance and inspection of hydraulic equipment and vehicles is to be undertaken to avoid a hazardous material release.
- Hazardous materials will not be stored on-site in large quantities, and secondary containment (*e.g.*, drip trays) will be used in areas of storage and transfer.

- Preventative measures, including daily vehicle inspections, inspection of hazardous material storage areas, and buffers surrounding sensitive areas (*e.g.*, wetlands), will be implemented.
- Vehicles, heavy equipment, and on-site buildings will be equipped with spill kits and drip trays of an appropriate size and composition.
- Fueling stations will be equipped with automatic shut-off nozzles and emergency isolation mechanisms.
- Storage of all dangerous goods will comply with the Workplace Hazardous Materials Information System (WHMIS) requirements.
- Transportation of dangerous goods will comply with Transport Canada's *Transportation of Dangerous Goods Act*.

In the unlikely event that an accidental spill of a hazardous material does occur, potential environmental effects will be reduced by following the spill response procedures in an emergency response and contingency plan that will be part of the PSEMP, which will include protocols for:

- Spill containment and clean-up
- Notification and reporting
- Required training, including emergency spill response scenarios

17.5.3.2 Potential Residual Environmental Effects

Depending on the quantity and type of material released and the location of the spill, a hazardous material spill could potentially seep into groundwater or runoff into surrounding environments and affect surface water, fish and fish habitat, wildlife and wildlife habitat, as well as vegetation and wetlands. Remediation efforts may also increase the demand for emergency services and restrict the use of the area and resources for traditional purposes by Indigenous persons, as well as public use.

Wastewater will be collected and treated on site in a contained treatment plant such that wastewater, which may be potentially deleterious, would be contained and would not be released to the surrounding environment.

Given the expected limited spill volume, the low likelihood of large spill scenarios, and anticipated effectiveness of response plans (including spill containment), and onsite treatment of wastewater, it is not likely that these spills would result in a release to adjacent properties or to watercourses.

In the unlikely scenario of a hazardous material being spilled and then reaching a sensitive environmental feature (*e.g.*, the river), and/or resulting in a protected species being harmed, an adverse environmental effect could result. A substantive effect arising from these possibilities, however, is considered unlikely as immediate measures will be taken to stop the spill and isolate and contain the affected area as soon as possible. An assessment of the affected area will be completed, and remediation will be undertaken as required.

There is a low likelihood that, if a spill of hazardous materials were to occur, it would result in adverse effects to the environment because of the mitigation and response measures that will be undertaken (*e.g.*, spill containment and clean-up). The residual adverse environmental effects of a hazardous material spill during all phases of the Project are not anticipated to be substantive. As such, with the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of an accidental release of a hazardous material on the atmospheric environment, water resources, fish and fish habitat, wildlife and wildlife habitat, vegetation and wetlands, Indigenous communities, and the socioeconomic environment during all phases of the Project are rated not significant.

17.5.4 Vehicle Accident

A Project-related vehicle accident could result in injury or loss of life, loss or damage to a vehicle, equipment, or Project infrastructure. Damage to transportation network infrastructure is possible, and delays to travel times may occur if lane closures are required to clean up after an accident. If a vehicle accident involved an animal, it would likely result in injury or mortality to the wildlife involved. There is also potential for fire and hazardous materials to be released into the environment; however, these scenarios are discussed separately in previous sections.

17.5.4.1 Risk Management and Mitigation

As will be outlined in a traffic management plan that will be part of the PSEMP the following mitigation measures will be applied to reduce the probability of a vehicle accident and any associated environmental effects.

- Traffic control measures (*e.g.*, signage, speed limits, restricted areas) will be implemented, as needed, to reduce the likelihood of vehicle collisions.
- Security measures will be in place during construction to prevent the general public from accessing the work site.
- Project staff will operate vehicles with due care and attention while on-site.
- Safety measures such as the use of backup alarms, designated parking areas, and proper storage of tools and materials in vehicles will be implemented.
- The use of cellphones while operating a vehicle will be prohibited as per law.
- Project staff will be appropriately licensed to operate vehicles on-site.
- Oversized loads will be transported to the Project site by licensed service providers.
- Vehicle drivers are expected to observe traffic rules and trucks will use only designated truck routes.
- All Project-related vehicles will abide by speed limits.
- In the case of a vehicle collision, the appropriate authorities will be notified.

If a vehicle collision results in a hazardous material spill or fire, the emergency response and contingency plan will be initiated.

17.5.4.2 Potential Residual Environmental Effects

The most likely effect of a vehicle accident during construction would be the damage or loss of a vehicle, damage to infrastructure, and potential for related work stoppage. The worst case involving a vehicle collision would most likely involve loss of life, fire, or the release of a hazardous material, although the probability of these events occurring is considered very low. The likelihood of a vehicle accident resulting in a serious injury or loss of life is reduced with the application of mitigation as described above.

In consideration of the low likelihood of an animal strike, or vehicle accident resulting in serious injury or loss, and the mitigation and response measures to be undertaken, the residual adverse environmental effects of a vehicle collision during all phases of the Project are not anticipated to be substantive. As such, with the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a vehicle accident on wildlife and wildlife habitat, and transportation during all phases of the Project are rated not significant.

17.5.5 Cofferdam Failure

If a partial or full cofferdam failure were to occur, injury or loss of life, or loss or damage to equipment or Project infrastructure could result. Water resources and the aquatic environment could be adversely affected due to a sudden change in flow. There is also potential for Project sediment, waste, and/or hazardous materials to be released into the environment if water breaches the cofferdam while construction is ongoing within, and would be considered a hazardous material spill, as discussed in section 17.4.2

17.5.5.1 Risk Management and Mitigation

The following mitigation will be applied to reduce the likelihood of cofferdam failure:

- Cofferdams will be designed and constructed to meet relevant standards and site-specific conditions.
- Applicable erosion and sediment control measures will be implemented to prevent erosion and sedimentation around cofferdams.
- Regular inspections of cofferdams will be conducted throughout construction and use, particularly before and after the spring freshet when river flows are strongest.
- Any potential repairs to cofferdams following severe weather events will be completed promptly before work resumes within the area.
- Strict protocols will be implemented for construction staff who will be working within cofferdams, including restricted access during periods of high flooding potential.

17.5.5.2 Potential Residual Environmental Effects

Cofferdams will be designed and built to meet relevant standards and specific conditions of the St. John River. Large rockfill material will be used as a base for cofferdams to increase stability, provide strong structural integrity, and reduce the possibility of fine sediment material releasing into the river. Following construction, routine inspections and maintenance will be carried out. The strong river flows and increased volume of water associated with the spring freshet in the St. John River could cause additional damage to cofferdams; but scheduled inspections and completion of any necessary repairs will be conducted promptly to ensure all structures meet specific conditions.

With these measures as well as standard best practices, there is a low likelihood that a sudden, catastrophic failure of a cofferdam and associated adverse effects to the environment will occur. Residual adverse environmental effects of cofferdam failure are therefore not expected to be substantive. In the extremely unlikely event of a complete cofferdam failure, effects on the downstream aquatic environment could be substantive. However, with the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a cofferdam failure on water resources and the aquatic environment during all phases of the Project are rated not significant.

17.6 OVERALL SUMMARY

NB Power will implement design features, mitigation measures, and operational practices intended to reduce the likelihood for accidents, malfunctions, and unplanned events to occur and/or the severity of such events if they did occur. Even with these measures in place, several potential events were deemed to be credible, and residual environmental effects on each of the identified VCs were assessed. In all cases, environmental effects that might arise from such scenarios were predicted to be unlikely to occur. As described above, catastrophic accidental events, such as a complete failure of a cofferdam (the environmental effects of which could be substantive), are not anticipated to occur because of careful Project planning, mitigation by design, and emergency response procedures. In this light, the residual effects of all credible accidents, malfunctions, and unplanned events on all potentially affected VCs during all phases of the Project are rated not significant.

17.7 REFERENCES

ECCC (Environment and Climate Change Canada). 2018. General nesting periods of migratory birds. Available at: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html#_zoneC_calendar.

ECCC. 2022. Guidelines to avoid harm to migratory birds. Available at: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html.

18.0 CLOSURE

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Appendix A

THE PROPONENT

Name of Proponent	New Brunswick Power Corporation (NB Power)
Corporate Address of Proponent	P.O. Box 2000, 515 King Street Fredericton, NB E3B 4X1
President & Chief Executive Officer	Lori Clark President and CEO (Acting)
Principal Contact Person for the Purposes of Environmental Impact Assessment	Anthony Bielecki, P.Eng. Tel.: (506) 458-6701 Cell: (506) 461-1625 Email: ABielecki@nbpower.com
Property Ownership	Refer to Section 1.5 of the EIA Registration Document

THE PROJECT

Name of Undertaking	Mactaquac Life Achievement Project (MLAP)
Project Overview	An overview of the Project is provided in Section 1.1 of the EIA Registration Document.
Purpose/Rationale/Need for Undertaking	The purpose/rationale/need for the Project is provided in Section 1.3 of the EIA Registration Document.
Project Location	The proposed Project is located at the existing Mactaquac Generating Station (MQGS), approximately 20 km west of Fredericton, New Brunswick. The MQGS is located on Parcel Identification Number (PID) 75258699. Refer to Figure 2.1 of the EIA Registration document for a site location map showing the location of the Project.
Siting Considerations	Project alternatives are described in Section 2.3 of the EIA Registration Document. Siting considerations are limited as the Project is the rehabilitation and repair of an existing facility.
Physical Components and Dimensions of the Project	A description of the existing MQGS is provided in Section 2.1 of the EIA Registration Document. A Project development area (PDA), which encompasses the anticipated area of physical disturbance associated with Project activities during construction is depicted on Figure 2.1.
Construction Details	An overview of Project construction activities is provided in Section 2.4 of the EIA Registration Document.
Operation and Maintenance Details	An overview of Project operation activities is provided in Section 2.5 of the EIA Registration Document.
Future Modifications, Extensions, or Abandonment	An overview of Project decommissioning activities is provided in Section 2.6 of the EIA Registration Document.
Project-Related Documents	Not applicable.

Description of the Existing Environment

The description of relevant features that are found within the Project location and surrounding areas that could potentially be affected by the Project are provided in Section 3.0, and within the descriptions of the specific valued components (VCs) found in Sections 6.0 to Section 14.0 of the EIA Registration Document.

Summary of Environmental Impacts

Potential environmental effects, or "impacts," of the various Project phases are provided in Sections 6.0 to Section 17.0 of the EIA Registration Document.

Summary of Proposed Mitigation

Mitigation by design or that will be implemented during all phases is provided in Sections 6.0 to Section 17.0 of the EIA Registration Document.

Public Involvement

A brief summary of the public involvement and engagement activities, both previously undertaken and planned as part of the Project, is provided in Section 4.0 of the EIA Registration Document.

Approval of the Undertaking

Permits, licenses, approvals, and other regulatory requirements and authorizations that may be required for the Project are discussed in Section 1.4 of the EIA Registration Document. A federal environmental assessment under the *Impact Assessment Act* (*IAA*) is not required; the Project is not a designated project as defined by the Project List under the *IAA*, as it is neither a new hydroelectric generating facility nor an expansion of 50% or more.

Funding

Funding for the Project is being provided entirely by NB Power.

Signature

Signature 2023-07-05

Date