PEI-New Brunswick Cable Interconnection Upgrade Project - VOLUME 4, The Northumberland Strait

Project No. 121811475

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abbreviations

%	Percent
°C	Degree Centigrade
µT	MicroTesla (0.000001 Tesla)
µV	Microvolt (0.000001 Volt)
AC	Alternating Current
ADCP	Acoustic Doppler Current Profiler
AFS	Aboriginal Fishery Strategy
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act, 2012*
CEPA	*Canadian Environmental Protection Act, 1999*
CFIA	Canadian Food Inspection Agency
cm	Centimetres
COSEWIC	Committee on the Status of Endangered Wildlife Species in Canada
CRA	Commercial, Recreational And Aboriginal
CSR	Canadian Seabed Research
CSSP	Canadian Shellfish Sanitation Program
DDT	Dichlorodiphenyltrichloroethane
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
DO	Dissolved Oxygen
EBSA	Ecologically and Biologically Sensitive Area
EC	Environment Canada
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EPP	Environmental Protection Plan
FSC	Food, Social, and Ceremonial Fisheries
GEV	Generalized Extreme Value
GFA	Ground Fishing Area
GNB	Government of New Brunswick
ha	Hectare
HFA	Herring Fishing Area

HPPA	*Heritage Places Protection Act, 1988*
HVAC	High Voltage Alternating Current
IBA	Important Bird Area
INFC	Infrastructure Canada
IPCC	Intergovernmental Panel on Climate Change
ISQG	Interim Sediment Quality Guidelines
kg	Kilogram
km	Kilometre
km/h	Kilometer per Hour
km^2	Square Kilometer
KP	Kilometre Post
kV	Kilovolt
LAA	Local Assessment Area
LFA	Lobster/Crab Fishing Area
m	Metre
m/s	Metres per Second
m^2	Square Metre
MBCA	*Migratory Birds Convention Act, 1994*
MCPEI	Mi'kmaq Confederacy of Prince Edward Island
MFA	Mackerel Fishing Area
mg	Milligram
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
mm	Millimetre
MW	Megawatt
NAFO	Northwest Atlantic Fisheries Organization
NB	New Brunswick
NB *SARA*	*New Brunswick Species at Risk Act, 2012*
NBDELG	New Brunswick Department of Environment and Local Government
NBDNR	New Brunswick Department of Natural Resources
NPA	*Navigation Protection Act, 1985*
NWPP	Navigable Waters Protection Program
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDA	Project Development Area

PEI	Prince Edward Island
PEI *EPA*	*PEI Environmental Protection Act, 1988*
PEIDCLE	PEI Department of Communities, Land and Environment
psu	Practical salinity Unit
PSW	Provincially Significant Wetlands
PWGSC	Public Works and Government Services Canada
RAA	Regional Assessment Area
RDL	Reportable Detection Limit
ROW	Right-of-Way
SAR	Species at Risk
SARA	*Species at Risk Act, 2002*
SFA	Scallop Fishing Area
SOCC	Species of Conservation Concern
SSS	Sidescan Sonar
SST	Sea Surface Temperature
t	Tonne
TAC	Total Allowable Catch
TOC	Total Organic Carbon
TRC	Technical Review Committee
TSS	Total Suspended Solids
USBOEMRE	United States Bureau of Ocean Energy Management, Regulation, and Enforcement
UXO	Unexploded Explosive Ordnance
VC	Valued Component
WAWA	Watercourse and Wetland Alteration

1.0 INTRODUCTION

Prince Edward Island Energy Corporation (PEIEC), with Maritime Electric Company, Limited (MECL) serving as construction agent, proposes to upgrade the electrical power interconnection between Prince Edward Island (PEI) and New Brunswick (NB).

The PEI-NB Cable Interconnection Upgrade Project (the "Project") includes construction and operation of a high voltage alternating current transmission system. The main Project components are:

- two 180 megawatt, 138 kilovolt submarine cables
- two landfall sites (where the submarine cable trenches are brought ashore)
- two termination sites (for converting submarine cables to overhead transmission lines or substation)
- three-phase, 138 KV transmission lines within NB
- expansion of the existing MECL substation in Borden-Carleton, PEI and upgrading of the New Brunswick Power Corporation (NB Power) substation in Memramcook, NB

The Project will span three geographic regions as shown in Volume 1, Figure 1.1 including:

- PEI – a landfall site will be constructed adjacent to the MECL substation in Borden-Carleton, and a termination site will be located within the substation
- The Northumberland Strait – two high voltage alternating current submarine cables will span approximately 16.5 km from Cape Tormentine to Borden-Carleton
- NB – a landfall site and termination site will be constructed in Cape Tormentine, and approximately 57 km of overhead transmission lines within new and existing easements will be built from Cape Tormentine to the existing NB Power substation in Memramcook

To reflect the three geographic regions, the environmental impact statement (EIS) for the Project is divided into four volumes:

- Volume 1 includes a detailed description of the overall Project, regulatory framework, consultation activities, and an overview of EIA methodology
- Volume 2 includes an assessment of potential environmental effects associated with land-based Project components and activities located in PEI.
- Volume 3 includes an assessment of potential environmental effects associated with land-based Project components and activities located in NB.
- Volume 4 (this volume) includes an assessment of potential environmental effects associated with marine-based Project components and activities located in the Northumberland Strait.

The following sub-sections provide an overview of Project components and activities located within the Northumberland Strait. A detailed description of the components and activities related to the Project is provided in Volume 1, Chapter 2.

1.1 DESCRIPTION OF PROJECT COMPONENTS IN THE NORTHUMBERLAND STRAIT

For the Northumberland Strait, the Project will require the installation of two submarine cables between the landfall sites of Cape Tormentine, NB and Borden-Carleton, PEI, a distance of 16.5 km (Figure 1.1).

1.1.1 Submarine Cables

Two submarine cables transmitting 360 MW combined at 138 kV each will be installed under the seabed of the Northumberland Strait. Each cable will be solid dielectric, three-core cable with galvanized steel armour and a medium- or high-density polyethylene (MHPE or HDPE) jacket. Transmission of electricity is through three copper conductors sheathed in lead within the cable interior. Oil is not used as an insulator in the chosen cable design. The cable is insulated with cross-linked polyethylene (XLPE) which is made from high density polyethylene and contains cross-linked bonds in the polymer structure creating a highly durable material.

1.1.2 Installation

The two cables will be installed in separate trenches, up to 200 m apart. The trenches will be excavated up to 1 m below grade where water depth exceeds 12 m and 2 m below grade in shallower or near-shore areas. The cable location in the near shore environment will be pre-trenched several months prior to cable installation and the trenches will be cleared of any in-filled sediment prior to laying of the cable. The method of excavation within nearshore environment will involve trenching with specialized marine excavators and cranes from a barge in water depths up to 12 m and a trenching remotely operated vehicle (TROV) with a saw cutter for the remaining marine sections. The trenches will range in width from less than 1 m to 5 m. The area of disturbance from the TROV is expected to be limited to a 10 m wide corridor, centred on the each cable.

Laying of the cables will be done using a cable-laying vessel. The cables will be placed on the marine bed on top of the planned trench location. Once both cables are placed on the marine bed, the TROV will be moved into the correct position and trenching and laying of the cable in the trench in water great then 12 m deep will be completed simultaneously. To ensure the cable is laid in the correct location within the corridor a dynamic positioning (DP) system will be used during the laying of cable. In the near-shore environment, cables will be laid directly into the pre-excavated trenches.

The land-based cable trench will be infilled with the originally excavated material immediately after cable installation. Trench infilling will extend from land into the near-shore environment to a water depth of up to 2 m, where possible. In waters deeper than 2 m, the trench will be left to infill naturally over time.

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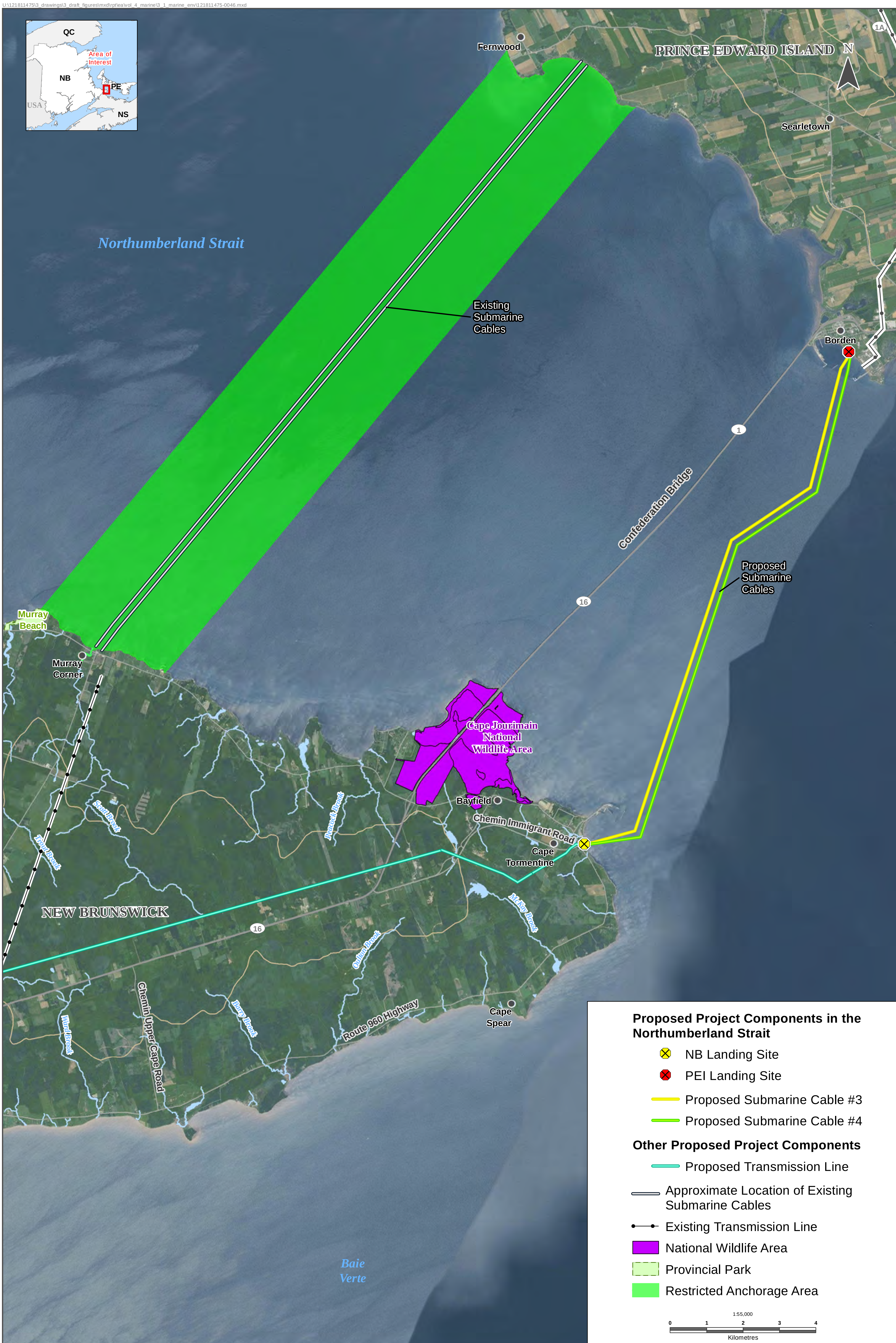

Sources: Base data and project data from GeoNB, CHS, SNB and NB Power.
Imagery - Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Project Components in the Northumberland Strait

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121811475 - PEI - NB Marine Cable Interconnection - Maritime Electric Company Limited

Figure 1.1

1.1.3 Landfall

Once at the landfall sites, the separate cable trenches will converge and the cables will be buried together in one single trench in NB and separated into two trenches in PEI. Cables will be separated by a minimum distance of 5 m when buried in a single trench. An excavator is generally required to excavate for the near-shore and land-based trenches.

1.1.4 Project Footprint

The Project footprint within the Northumberland Strait is 33 ha.

1.2 PROJECT PHASES AND SCHEDULE

The Project includes three phases: construction, operation, and decommissioning and abandonment.

Construction within the Northumberland Strait is scheduled to be conducted from May through early July 2016 with the pre-trenching of the inshore areas. Intertidal and land trenching, cable installation and connecting the cables to both the New Brunswick and PEI landfall sites will take place in October/November 2016. Energizing of the marine cables is scheduled for December 2016.

Operation will begin in December 2016. The predicted useful service life of the Project is estimated to be 40 years.

Land-based infrastructure will be decommissioned at the end of its useful service life, in accordance with the applicable standards and regulations at that time. It is believed that the cable will be detached from the PEI substation and buried on site, while for the New Brunswick side, the cable will be cut and removed to the high water mark. Within the Northumberland Strait the cable will remain in place.

Key Project timelines are provided in Volume 1, Section 2.5.

2.0 ENVIRONMENTAL SETTING AND POTENTIAL INTERACTIONS

2.1 ENVIRONMENTAL SETTING

The Northumberland Strait is a tidal water body separating PEI and the coasts of eastern New Brunswick and northern Nova Scotia. The Strait extends 225 km and varies in width between 13 and 43 km (Historica Canada 2015). The climate in the region is a moderate, cool and moist maritime climate. The Strait is known for having some of the warmest ocean waters in eastern Canada, reaching up to 20 °C during summer months. This is mainly due to the shallow depths. Additional information on climate is provided in Sections 3.1 and Chapter 4.

Bathymetry in the Strait has an average depth of 22 m, ranging from 6 to almost 70 m. The Project is located in the central part of the Strait. In the area between Cape Tormentine, NB and Borden, PEI the depths average 28 m (AMEC 2007). The complexity of geomorphology in the Strait is primarily due to sand transport, erosion by ice, and bottom fishing activity such as scallop dragging, which results in a dynamic benthic environment. Most of the substrate between Cape Tormentine and Borden is part of the Bouctouche sand and gravel deposit, and is overlain with a layer of sand (AMEC 2007). Detailed information on the physical marine environment is provided in Section 3.1.2.

The Northumberland Strait is home to a wide range of marine flora and fauna including macrophytes, benthic infauna, plankton, fish and shellfish, marine mammals, marine and shore birds, and migrating sea turtles. Many of these species are of economic importance to the local residents through industries such as commercial fisheries and aquaculture. Commercial shellfish species such as lobster (*Homarus americanus*), rock crab (*Cancer irroratus*), eastern oyster (*Crassostrea virginica*) and deep-sea scallop (*Placopecten magellanicus*) have contributed substantially to the local economy. Commercial finfish in the Strait include Atlantic cod (*Gadus morhua*), white hake (*Urophycis tenuis*), American plaice (*Hippoglossoides platessoides*), Atlantic halibut (*Hippoglossus hippoglossus*), winter flounder (*Pseudopleuronectes americanus*), witch flounder (*Glyptocephalus cynoglossus*) and yellowtail flounder (*Pleuronectes ferruginea*), Atlantic herring (*Clupea harengus*), bluefin tuna (*Thunnus thynnus*) and Atlantic mackerel (*Scomber scombrus*). Although most of these species are harvested commercially, the main commercial fisheries in the Strait include lobster, crab, herring and scallop (AMEC 2007; JWEL 2001). Additional information on biota in the Strait is available in Section 3.1.2, and additional information on Commercial, Recreational and Aboriginal Fisheries is available in Sections 3.2 and Section 3.4.

The Project is adjacent to sensitive marine areas on both the New Brunswick and PEI sides of the Strait. The Cape Jourimain National Wildlife Area, which was designated in 1980 due to the variety of waterfowl and shorebirds that inhabit the area, is located approximate 1.8 km west of the cables in New Brunswick. In PEI, there is an Important Bird Area (IBA) in Bedeque Bay adjacent to the Project. This was designated for mudflat habitat for migratory shorebirds. Additional information on sensitive marine areas is available in Section 3.1.2.

The Northumberland Strait is a minor shipping route. There are three commercial shipping ports (PEI: Summerside and Charlottetown; Nova Scotia: Pictou). The majority of marine shipping traffic passes along the Gulf of St. Lawrence to the north of PEI. The Confederation Bridge is adjacent to the Project and acts as the main route from New Brunswick to PEI. Ferry service occurs between Wood Islands, PEI and Caribou, Nova Scotia, at the eastern end of the Northumberland Strait, more than 50 km away from the Project between May and December. Oil and gas exploration has occurred along the Strait in all three Maritime Provinces. The majority of these exploration licenses and permits are for onshore development, with only a small area of the boundaries extending into surrounding marine coastal waters (AMEC 2007; JWEL 2001).

The Strait supports a tourism industry, mainly during summer months. This includes beach facilities, campgrounds, parks and cottage developments.

2.2 POTENTIAL INTERACTIONS

Potential valued components (VCs) were reviewed to determine if there was potential for interaction with Project components located in the Northumberland Strait (Table 2.1). This volume considers Project interactions in the marine environment; therefore terrestrial-based components of the environment are considered separately in Volumes 2 (PEI) and 3 (NB).

Table 2.1 Interactions Between Potential Valued Components and Project Components Located in the Northumberland Strait

Valued Component	Interaction with Project Components Located in the Northumberland Strait?
Atmospheric Environment	No
Groundwater Resources	N/A
Freshwater Environment	N/A
Terrestrial Environment	N/A
Marine Environment	Yes
Land Use	N/A
Commercial, Recreational and Aboriginal Fisheries	Yes
Socioeconomic Environment	N/A
Heritage Resources	Yes
Other Marine Users	No
Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons	Yes
Note: N/A = Not Applicable to Volume 4 (Northumberland Strait)	

Marine Environment, CRA Fisheries, Historic Resources, and Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons are carried through this environmental assessment as VCs (Chapter 3). Socioeconomic Environment is addressed within the PEI and NB volumes.

The following sub-sections provide rationale for not including Atmospheric Environment and Other Marine Users as VCs.

2.2.1 Atmospheric Environment

The Atmospheric Environment can be characterized by three components; air quality, climate and sound quality. The Atmospheric Environment is typically described as:

- Air quality, is characterized by the measure of the constituents of ambient air, and includes the presence and the quantity of air contaminants in the atmosphere.
- Climate is characterized by the composite or generally prevailing meteorological conditions of a region, including temperature, air pressure, humidity, precipitation, sunshine, cloudiness and winds, throughout the seasons, averaged over a number of years (typically a 30 year period of record). In relation to climate change, understood to be influenced by releases of greenhouse gases (GHGs) from human activities as well as natural sources, Project-based releases of GHGs are typically used as an indicator of potential environmental effects on climate. The assessment of potential environmental effects of climate on the Project is addressed in Chapter 4 (Effects of the Environment on the Project).
- Sound quality is characterized by the type, character, frequency, intensity, and duration of noise (unwanted sound) in the outdoor environment. The audible frequencies for humans are in the range of 20 to 20,000 Hertz (Hz). Vibration, identified as oscillations in matter that may lead to unwanted sound or stress in materials, is typically considered as part of sound quality.

For the purpose of Project, components assessed in this volume (Northumberland Strait), combustion gases are considered in relation to air quality, and GHGs released during combustion processes are considered in relation to climate change, as those are the primary air contaminants associated with this type of project. Noise is reviewed on the basis of sound pressure and consideration of vibration.

2.2.1.1 Existing Conditions

The information on existing conditions in relation to air quality, GHGs and sound quality is a high level presentation because the interaction between the marine part of the Project and these attributes of the environment (air quality, GHGs and sound quality) is expected to be limited.

The existing air quality in the vicinity of the Project in the Northumberland Straight is expected to be good most of the time; however, no monitoring data exist to support that. Monitoring of ambient air quality is focused on areas of higher population. Therefore, air quality in the marine environment has not been studied in great detail.

Climate in the Northumberland Straight is a moderate, cool and moist maritime climate. Weather forecasts are available via Environment Canada (Environment Canada 2015); however, no published climate normals are publically available for the Northumberland Strait. Climate normals and GHG emissions for PEI are provided in Volume 2, and those for New Brunswick are provided in Volume 3. Wind and wave height for the Northumberland Strait are addressed below in Section 3.1.2.

Sound quality is typically influenced by natural sounds such as wildlife, noise from waves and marine vessel travel in the area. No baseline data were collected as limited contribution from the Project to sound quality is expected and no sensitive receptors exist in the PDA.

2.2.1.2 Potential Interactions with Project Components

2.2.1.2.1 Construction

Project-related releases of air contaminants will include small amounts of combustion gases from the operation of marine construction equipment required to install the two submarine cables. This installation will require the use of vessels and barges to support cable installation activities across the Northumberland Strait and excavation of trenches near the landfall sites.

Releases of GHGs will occur in small quantities from fuel combustion in heavy marine equipment Project activities.

Combustion gases from the Project are not likely to cause any notable or substantive changes in air quality with the use of well-maintained equipment. The construction phase in the Strait is short in duration and the contractor will be required to follow a preventative maintenance schedule for equipment. As a result, Project-related releases of air contaminants to the atmosphere are not likely to cause the ambient air quality standards to be exceeded.

The quantities of GHGs released to the atmosphere during construction are expected to be very small in comparison to provincial and national totals. These can be mitigated through the use of well-maintained equipment and implementation of an idling awareness program to reduce unnecessary idling.

During construction, sound emissions and vibration may result from the operation of heavy equipment. However, no sensitive receptors exist for the marine component.

2.2.1.2.2 Operation, and Decommissioning and Abandonment

No substantive emissions of air contaminants, GHGs, or noise will occur during Project operation. Emissions during eventual decommissioning and abandonment are expected to be similar or less than those that would occur during construction.

2.2.1.3 Summary

Based on the lack of interactions noted above, and the planned implementation of known and proven mitigation, no substantive interactions between the Project and the Atmospheric Environment are anticipated. Atmospheric Environment is therefore not considered as a VC in the Northumberland Strait for the purpose of environmental assessment.

2.2.2 Other Marine Users

The Northumberland Strait is used by a variety of maritime industries. Potential interactions between marine users and Project components in the Strait are considered in two phases: first, during construction when the submarine cables are being installed in subsurface trenches; and second, during cable operation and maintenance. Potential effects of Project components on commercial and traditional fisheries are discussed in Section 3.2 and 3.4.

2.2.2.1 Existing Conditions

2.2.2.1.1 Federal Law Enforcement and Safety Agencies

Fisheries and Oceans Canada (DFO), including the Canadian Coast Guard and Fisheries Officers, and Transport Canada conduct patrols, provide marine rescue services, and service navigational aids in the Northumberland Strait.

Marine Traffic

The Northumberland Strait is a minor shipping route as there are few commercial shipping ports (PEI: Summerside and Charlottetown; Nova Scotia: Pictou) and the majority of marine shipping traffic passes along the Gulf of St. Lawrence to the north of PEI. During construction, notifications to the appropriate marine agencies (described below) will alert commercial vessel traffic to marine construction activities occurring in the area and transit through the Northumberland Strait will remain accessible. In the long-term, a similar notification procedure will be employed when maintenance is being conducted, and once in place, the position of the submarine cables will be identified on updated mariner charts for the region. Otherwise the submarine cables are unlikely to have any interaction with commercial vessel traffic.

Ferry crossing services between Wood Islands, PEI and Caribou, Nova Scotia are in the eastern end of the Northumberland Strait, more than 50 km away from the submarine cable route. Therefore, it is unlikely there will be any interaction between the ferry services and the Project, both during construction, and operation and maintenance.

Oil and Gas

There are marine oil and gas lease sites along New Brunswick side of the Northumberland Strait, and exploratory drilling has been conducted. No active oil and gas activity is scheduled during the installation of the cables. Once in place, the position of the submarine cables will be identified on updated mariner charts for the region. This will allow future marine oil and gas activities to avoid interaction with the operation of the Project.

Tourism and Recreational Activities

There are several commercial outfitters providing recreational opportunities including, recreational boating, fishing tours, kayaking, and paddleboard rental, as well as recreational diving. During construction, notifications to the appropriate marine agencies (described below) will alert vessel traffic to marine construction activities occurring in the area. Once in place, the position of the submarine cables will be identified on updated mariner charts for the region. During operation, recreational activities and service providers are unlikely to interact with buried cable.

For a review of potential interactions between marine wildlife please refer to the Marine Environment chapter (Section 3.1).

Military Activities

The Canadian military periodically conduct search and rescue exercises in the Northumberland Strait. During construction there is unlikely to be interaction between the Project and military activities as communication of Project activities will alert local safety operators to the location of cable installation and passage through the Northumberland Strait will not be blocked. Once in place, the position of the submarine cables will be identified on updated mariner charts for the region. During operation and maintenance, it is unlikely that military activities will interact with the buried cables.

Research

There are ongoing research programs examining aspects of the fisheries, oceanography, and marine habitats of the Northumberland Strait, such as the Northumberland Strait Environmental Monitoring Partnership (NorST-EMP). It is unlikely there will be interaction between the Project and ongoing research programs as construction will not block access along the Strait, and once installed, there will be no fishing exclusion areas around the cable impeding access.

Existing Ocean Infrastructure

There are two existing submarine electrical transmission cables in the Strait between Murray Corner, New Brunswick and Fernwood, PEI operated by MECL that were installed in 1977. Bell Aliant has two fibre optic telecommunications cables from Caribou, Nova Scotia to Wood Islands, PEI. There is an additional fibre optic cable owned by Eastlink connecting Port Hood, Nova Scotia with Gaspereau, PEI. The nearest subsea ocean infrastructure to the Project is the Confederation Bridge which is 500 m from the Project route at the closest point. At these distances, the Project will not interact with the bridge subsea infrastructure either during construction or operation and maintenance.

2.2.2.2 Potential Interactions with Project Components

2.2.2.2.1 Construction

Project construction will not obstruct passage through the Northumberland Strait and the activities of other marine users will not be impeded. During construction, exclusion zones around Project vessels may be implemented for navigation of vessel traffic. The Canadian Coast Guard will be informed of marine associated work and a Notice to Mariners issued to alert vessel traffic of construction activities. Once construction is complete, no fishing exclusion zones or fishing gear restrictions will be enforced within or around the Project footprint.

2.2.2.2.2 Operation, and Decommissioning and Abandonment

Once submarine cables are installed, there is unlikely to be any interaction with the Project and federal law enforcement and rescue services.

Mitigation measures similar to those used for construction will be implemented during operation and maintenance activities. Once in place, the position of the submarine cables will be identified on updated mariner charts for the region. Users will have continued access to the marine area in the vicinity of the Project with minimal disruption. This is reflective of what is currently in place for the existing submarine cables between New Brunswick and PEI.

2.2.2.3 Summary

Subsea cables have been in operation in the Northumberland Strait since the late 1970s. These cables have not impeded use of the Strait by other ocean users. Due to the short-term construction period and the installation design (i.e., cable burial) and marking of the cables on maritime charts, there will be no substantive interactions between the Project and other ocean users. Therefore Other Marine Users is not considered as a VC in the Northumberland Strait for the purpose of environmental assessment.

3.0 ENVIRONMENTAL EFFECTS ASSESSMENT

3.1 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON THE MARINE ENVIRONMENT

The Marine Environment has been selected as a valued component (VC) based on Project interactions with marine fish and fish habitat and marine wildlife and wildlife habitat. This VC includes marine fish, marine mammals, sea turtles and marine birds. Special consideration is given to marine species at risk (SAR) and Commercial, Recreational and Aboriginal (CRA) fishery species.

The Project has the potential to affect marine populations (foreshore and subtidal) in the Northumberland Strait between PEI and New Brunswick. During construction, installation of the submarine cables has the potential to affect marine populations, including impacts to water quality and disruption of the benthic habitat. During operation, there are potential effects resulting from the electromagnetic fields (EMF) emitted by the two subsea cables.

Marine fish and fish habitat is included in this VC because of regulatory protection of fish and fish habitat and the intrinsic relationship of fish and fish habitat to the local CRA fisheries and local communities. Discussion of marine fish and fish habitat focuses on resident and migratory marine fish and their habitat likely found within the waters surrounding the planned installation of submarines cables in the Northumberland Strait between PEI and New Brunswick.

Marine wildlife and wildlife habitat has been included because of regulatory protection and ecological, economic and recreational importance. Changes in marine wildlife abundance or diversity might adversely alter ecosystem function as well as affect the ability of humans to use and enjoy natural resources.

This VC is closely related to other marine VCs in this volume because of potential changes to marine populations: Section 3.2 - Commercial, Recreational and Aboriginal Fisheries; and Section 3.3 - Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons.

3.1.1 Scope of Assessment

This section defines and describes the scope of the assessment of potential effects on the Marine Environment.

3.1.1.1 Regulatory and Policy Setting

Effects on the Marine Environment associated with the Project are subject to federal and provincial regulatory requirements.

3.1.1.1.1 Federal

Canadian Environmental Assessment Act

The federal requirements for conducting an environmental assessment are described in the *Canadian Environmental Assessment Act, 2012* (*CEAA 2012*) and the Regulations Designating Physical Activities (SOR/2012-147). The Act and associated regulations identify the physical activities that are "designated projects" subject to *CEAA 2012*, and may require environmental assessment by the Canadian Environmental Assessment Agency (the CEA Agency), the Canadian Nuclear Safety Commission (CNSC) or by the National Energy Board (NEB).

A new transmission line may be considered a designated project and be subject to requirements as described in *CEAA 2012* depending on the length of the transmission line and the magnitude of the voltage. The NEB facilitates the EIA process for international or interprovincial transmission line projects that are deemed designated projects. As the new electrical transmission line is to be less than the requirements to be listed as a designated project under the regulations, it is not subject to facilitation by the NEB and an official Project Description for the Project will not be required to be filed with the CEA Agency or other Responsible Authority under *CEAA 2012*.

Section 67 of *CEAA 2012* sets the framework for the environmental assessment of projects being carried out on federal land that are not considered designated projects and for which a full EIA under the Regulations Designating Physical Activities is not required. As the seabed of the Northumberland Strait is federal crown land it is subject to requirements under section 67 of CEAA. Section 67 states "*an authority must not carry out a project on federal lands, or exercise any power or perform any duty or function conferred on it under any Act of Parliament other than this Act that could permit a project to be carried out, in whole or in part, on federal lands, unless:*

> *(a) The authority determines that the carrying out of the project is not likely to cause significant adverse environmental effects; or*
> *(b) The authority determines that the carrying out of the project is likely to cause significant adverse environmental effects and the Governor in Council decides that those effects are justified in the circumstances under subsection 69(3)*."

Therefore, this project is subject to review by a federal authority in order to determine whether the carrying out of the project will cause significant adverse effects on the surrounding environment, or if any potential significant adverse effects are justifiable.

Fisheries Act

The federal *Fisheries Act* protects fish, including marine mammals and marine reptiles. The definitions of fish and fish habitat established under the *Fisheries Act* are:

- "Fish" includes (a) parts of fish, (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

- "Fish habitat" means spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly to carry out their life processes.

Quality of marine fish habitat incorporates a variety of biophysical parameters, including substrate. Water quality parameters that influence habitat suitability for marine fish include temperature, salinity, dissolved oxygen (DO), total suspended solids (TSS) and turbidity.

CRA fishery species are primarily protected under federal legislation and regulations, and are socially and economically important. They are defined by the *Fisheries Act*, 2012 as follows:

- Commercial fisheries are recognized as fish species harvested under license for the purpose of sale.
- Recreational fisheries are recognized as fish species targeted by anglers for personal use or sport, as well as coarse and forage fish which support this fishery.
- Aboriginal fisheries are recognized as fish species caught by Aboriginal groups for subsistence, social or ceremonial purposes. In the absence of supporting information regarding Aboriginal fisheries, Aboriginal fisheries are considered to include all fish species, including those fished recreationally and commercially, and those that support those fisheries.

Management of CRA Fisheries resources in Canada is the mandate of Fisheries and Oceans Canada (DFO), the regulatory agency that is responsible for implementing the requirements of the *Fisheries Act*. Key sections of the *Fisheries Act* that apply to Project activities for marine fish and fish habitat of CRA Fisheries include:

- Section 35, which addresses serious harm to fish and fish habitat
- Section 36, which addresses pollution of fish habitat

Fishing within the Maritime Provinces (New Brunswick, Nova Scotia and PEI) and adjacent tidal waters is regulated through the Maritimes Provinces Fisheries Regulations under the federal *Fisheries Act*. These regulations define, and are intended, to regulate and manage commercial and recreational fisheries within the Maritimes, and outline acceptable timing and methods for capture. The Maritime Provinces Fishery Regulations list the following estuarine and marine recreational fish species:

- clams (bar clams [Atlantic surf clam, *Spisula solidissima*], bay quahogs [*Mercenaria mercenaria*], razor clams [*Ensis* sp.], and soft-shell clams [*Mya arenaria*])
- gaspereau (*Alosa pseudoharengus* and *Alosa aestivalis*)
- mussels (*Mytilus edulis*)
- oysters (*Crassostrea virginica*)
- anadromous salmon
- American shad (*Alosa sapidissima*)
- Atlantic silverside (*Menidia menidia*)
- rainbow smelt (*Osmerus mordax*)
- striped bass (*Morone saxatilis*)
- sturgeon (*Acipenser* sp.)
- Atlantic tomcod (*Microgadus tomcod*)

- trout (marine *Salvelinus* sp., *Salmo* sp. and *Oncorhynchus* sp.)
- white perch (*Morone americana*)

The *Marine Mammal Regulations* of the *Fisheries Act* are intended to protect marine mammals, specifically Section 7, which states, "No person shall disturb a marine mammal except when fishing for marine mammals under the authority of these regulations". The *Oceans Act* is intended to promote the sustainability of marine species and protects their habitat through the establishment of marine protected areas.

Species at Risk Act

Fish and wildlife species at risk are protected by the *Species at Risk Act* (*SARA)*, which is one part of a three-part Government of Canada strategy for the protection of species at risk. The *SARA* applies to all fish and wildlife species listed in Schedule 1 as being at risk, and their critical habitat, within all federal lands in Canada. The status of fish and wildlife species are assessed and designated by the Committee on the Status of Endangered Wildlife Species in Canada (COSEWIC), which recommends a designation for legal protection by being officially listed under *SARA*. One of the key considerations under *SARA* for protection of listed species at risk is protection of the species' habitat.

Canadian Environmental Protection Act

The *Canadian Environmental Protection Act*, 1999 (*CEPA*), and specifically the *Disposal at Sea Regulations*, protect marine fish and fish habitat indirectly. These regulations (i.e., the Disposal at Sea provisions of Part 7, Division 3 of *CEPA*, under the authority of Environment Canada; *CEPA* 1999), stipulate that dredging and disposal in the marine environment requires a permit and that sediment be screened for potential chemical contaminants.

Migratory Birds Convention Act

The majority of native bird species are protected under the *Migratory Birds Convention Act*, 1994 (*MBCA*), enforced by the Canadian Wildlife Service branch of Environment Canada. The key section of the *MBCA* that applies to the Project is s.5.1 which addresses substances in waters that might harm migratory birds.

3.1.1.1.2 Provincial

Prince Edward Island

PEI *Environmental Protection Act*

The regulatory framework for conducting environmental impact assessments (EIAs) in PEI is set forth in Section 9 of the PEI *Environmental Protection Act* (PEI *EPA*).

The interpretation of the PEI *EPA* is provided in Volume 1, Chapter 1. The term "undertaking" is interpreted to include any project which (i) may cause the emission or discharge of any contaminant into the environment; (ii) have an effect on any unique, rare, or endangered feature of the environment;
(iii) have a significant effect on the environment or necessitate further development which is likely to have a significant effect on the environment; or (iv) cause public concern because of its real or perceived effect or potential effect on the environment.

Section 9(1) of the PEI *EPA* states that "*no person shall initiate any undertaking unless that person first files a written proposal with the Department and obtains from the Minister written approval to proceed with the proposed undertaking*".

Furthermore, Section 9(2) of the PEI *EPA* states that the Minister, in considering a proposal submitted pursuant to Section 9(1), may require the Proponent to carry out an EIA, submit an EIS, notify the public of the proposed undertaking, and to provide opportunity for the public to comment.

Section 9(3) of the PEI *EPA* states that "*an environmental assessment and environmental impact statement shall have such content as the Minister may direct*".

Based on the PEI *EPA*, an EIA must be conducted for the Project, and an Environmental Impact Statement (EIS) must be presented to the Minister for approval of the undertaking. Consultation with the PEI Department of Communities, Land and Environment (PEIDCLE) has confirmed the need for an EIA for the Project.

An EIA must be completed and the corresponding EIS prepared and submitted to enable a review of the Project by the Technical Review Committee (TRC), comprised of provincial regulatory agencies as well as federal regulatory agencies, if required. The outcome of the EIA review process will determine if the Project should be approved, including any approval conditions.

PEI *Wildlife Conservation Act*

Species at risk are provincially protected in PEI under the PEI *Wildlife Conservation Act*. The purpose of this Act is to provide protection to endangered species and their habitats, as listed in *SARA*, *Fisheries Act* and *MBCA*. The PEI *Wildlife Conservation Act* is overseen by the PEIDCLE.

Watercourse, Wetland and Buffer Zone Activity Permit

Fish habitat is indirectly protected under the requirement for a Watercourse, Wetland and Buffer Zone Activity permit for all works in or within 15 m of a watercourse or wetland in PEI. Permits are required for vegetation clearing, soil excavation, construction or landscaping activities within 15 m of a watercourse or wetland, including any stream, spring, creek, brook, river, lake, pond, bay, estuary or coastal body.

New Brunswick

New Brunswick *Clean Environment Act—Water Quality Regulation*

The *Water Quality Regulation* is the main regulatory instrument in NB for regulating the release of effluents to the waters of the Province, which include coastal water within the jurisdiction of the Province, groundwater and surface water. Section 3(1) of the Regulation requires that any source of substances that may directly or indirectly cause water pollution or release of substances to the waters of the Province must apply for and obtain a Certificate of Approval under that regulation.

The Regulation defines "water pollution" as "*(a) any alteration of the physical, chemical, biological or aesthetic properties of the waters of the Province, including change of the temperature, colour, taste or odour of the waters, or (b) the addition of any liquid, solid, radioactive, gaseous or other substance to the waters of the Province or the removal of such substance from the waters of the Province, which renders or is likely to render the waters of the Province harmful to the public health, safety or welfare or harmful or less useful for domestic, municipal, industrial, agricultural, recreational, or other lawful uses or harmful or less useful to animals, birds or aquatic life*."

The activities related to the operation of the source must be conducted in accordance with the terms and conditions outlined in the approval. Approvals define site-specific requirements for individual facilities, including testing and monitoring, discharge limits, reporting, emergency response and environmental management measures.

New Brunswick *Clean Water Act—Watercourse and Wetland Alteration Regulation*

The water quality of watercourses and wetlands (including tidal estuaries) are protected in New Brunswick under the *Clean Water Act*. Activities that could alter water quality of watercourses and wetlands are regulated under the *Watercourse and Wetland Alteration Regulation* of the *Clean Water Act*.

Fish habitat is indirectly protected under the *Watercourse and Wetland Alteration Regulation* 90-80 (WAWA Regulation). Under the WAWA Regulation, watercourse and salt marsh alteration permits are required for vegetation clearing, soil excavation, construction or landscaping activities within 30 metres (m) of a watercourse or wetland, including marine shore drainage areas, intertidal zones and estuarine environments.

New Brunswick Coastal Areas Protection Policy

Further protection for New Brunswick coastal areas is provided under the Coastal Areas Protection Policy for New Brunswick. This policy is governed by the Department of Environment and Local Government (NBDELG) and aims to protect local coastal features such as beaches, dunes and coastal marshes, while maintaining a commitment to manage the sustainable development of provincial coastal areas. To achieve this goal, the policy identifies sensitive areas or zones within which specific types of activities are allowed, prohibited, or subject to environmental review. This policy must be consulted before work is planned near coastal areas.

New Brunswick Wetlands Conservation Policy

Wetlands are regulated in New Brunswick by the NBDELG, according to the objectives of the New Brunswick Wetlands Conservation Policy (GNB 2002), which are to maintain wetland function and to protect wetland habitat through securement, stewardship, education, and awareness. Specifically, the policy does not support most activities that pose a risk to provincially significant wetlands (PSWs). PSWs are defined as wetlands having provincial, national, or international importance, namely: coastal marshes; wetlands designated under other conservation-based agencies; wetlands that contain species listed under the *New Brunswick Species at Risk Act* (NB *SARA*); and wetlands with important ecological, hydrological function, or social (values) functions.

New Brunswick *Species At Risk Act*

Species at risk in New Brunswick are protected under the New Brunswick *SARA*, which shares many similarities with the federal *SARA*. The New Brunswick *SARA* is governed by the New Brunswick Department of Natural Resources (NBDNR) and applies to only those species listed within its Schedule A. The prohibitions state that, "no person shall kill, harm, harass or take any individual that is listed as an extirpated species, an endangered species or a threatened species".

3.1.1.2 The Influence of Consultation and Engagement on the Assessment

As outlined in Volume 1, Section 3.2 (Consultation and Engagement), environmental assessment scoping documents were sent to provincial regulators in PEI and New Brunswick, as well as Public Works and Government Services Canada (PWGSC). Environment Canada, Transport Canada, DFO and CEA Agency received the scoping documents through the provincial technical review committees (TRCs). Responses were received from TRC committees in New Brunswick and PEI no response has been received from PWGSC. Concerns were raised regarding the interaction between fish and EMF emitted from the submarine cables.

A meeting was held with DFO on May 6, 2015 to introduce the Project. Representatives of the habitat protection branch and commercial fisheries branch were present, as well as MECL and Stantec. DFO subsequently provided feedback on issues and concerns to be addressed in the EA. Based on concerns regarding sediment generation in the marine environment, the method of trenching was re-evaluated by MECL and PEIEC and a TROV with a saw cutter will be used in lieu of plowing or water jetting.

First Nations engagement was initiated with the Mi'kmaq Confederacy of PEI (MCPEI) in April 2015. No official correspondence has been received resulting from the meeting, although during the meeting there were concerns regarding potential impacts to fisheries in the Northumberland Strait resulting from the Project. Issues concerning CRA Fisheries are discussed in the CRA Fisheries VC (Section 3.2).

Consultation held with fisheries groups (see detailed descriptions in Volume 1, Section 3.2) resulted in concerns regarding sedimentation, EMF on commercial fish species as well as anticipated decreases in landings resulting from the Project and timing of the marine construction. Issues regarding sedimentation and EMF are discussed in Section 3.1 and issues regarding commercial fisheries are discussed in Section 3.2. The concerns associated with the timing of marine construction was re-evaluated by the

MECL and PEIEC and the installation of the submarine cables is now planned on being conducted in October and November of 2016 after the Fall lobster fishery.

3.1.1.3 Potential Environmental Effects, Pathways and Measurable Parameters

Marine components of the Project have the potential to affect habitat area, water and sediment quality, mortality, underwater acoustic environment and the behaviour of fish and marine wildlife (e.g., migration, feeding, and reproduction) that could result in changes in the populations of marine species in the assessment area. Based on these potential interactions and knowledge of the Project and its associated activities, the potential effect of change in populations of marine species was selected for assessment.

To adequately characterize the potential effects of the Project on the Marine Environment, measurable parameters are used to represent each type of predicted effect. Effective parameters are measurable and quantifiable (e.g., direct habitat loss). Some effects on marine populations lack defined parameters to measure effects and are therefore qualitative and rely on professional judgment and past project experience.

Table 3.1 summarizes the potential effects, effect pathways and measureable parameters for the Marine Environment VC.

Table 3.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for the Marine Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s)
Change in Marine Populations	• Direct (mortality, injury, health, behaviour) and indirect (habitat loss, sound levels, water quality) mechanisms on marine populations.	• Mortality (loss of individuals). • Habitat area (m^2). • Water quality. • Sediment quality. • Underwater acoustic environment • EMF.

3.1.1.4 Boundaries

3.1.1.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the Marine Environment are presented in Figure 3.1 and defined below.

- Project Development Area (PDA): The PDA is a 220 m wide corridor extending approximately 16.5 km between Borden-Carleton and Cape Tormentine. This includes the 10 m wide disturbance area for each submarine cable and the 200 m separation distance between the two cable trenches. The actual area of physical disturbance during construction is approximately 33 ha.
- Local Assessment Area (LAA): The LAA includes the PDA area and extends 1 km on either side of the PDA; the LAA is the maximum area where Project-specific environmental effects can be predicted and measured with a reasonable degree of accuracy and confidence.

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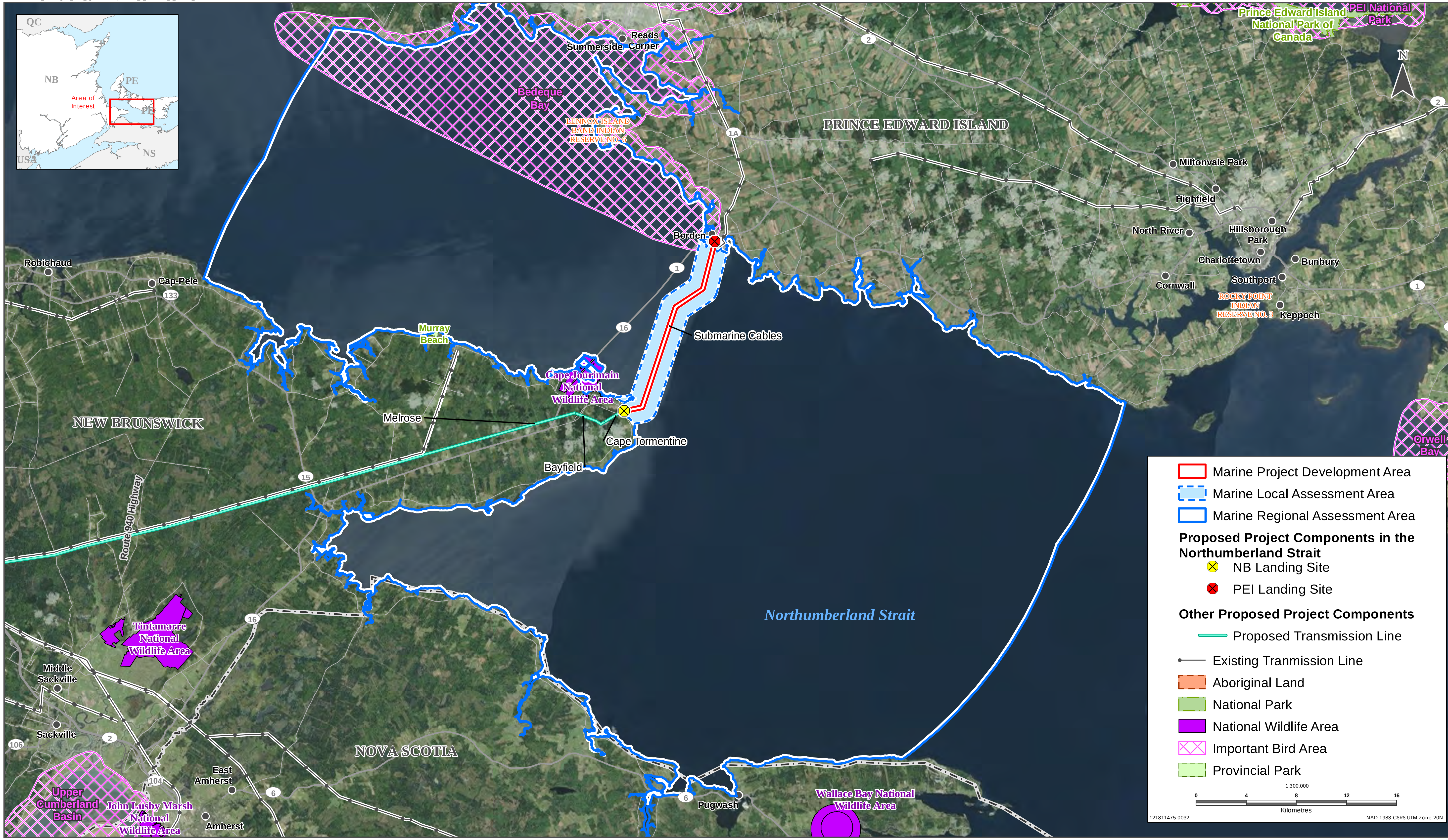

Sources: GeoNB, NB Power, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

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Marine Environment Assessment Boundaries

Figure 3.1

- Regional Assessment Area (RAA): The RAA is the area for the assessment of *SARA* or CRA species on a regional scale and is defined as a 70 km wide corridor centered on the subsea cables.

3.1.1.4.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the Marine Environment include construction, operation and maintenance, and decommissioning and abandonment. Total construction time in the marine environment will take place over a 20 to 25 week period. Pre-trenching in water less than 12 m is scheduled to be conducted from May to early July 2016, while the remaining trenching and cable installation are scheduled to be installed in October and November 2016. Operation will begin following construction and is anticipated to continue for the life of the Project (approximately 40 years). Decommissioning and abandonment would take place following the useful service life of the Project and would be carried out in accordance with regulations in place at that time.

The timing windows for in-water construction has been planned for May through early July in waters less than 12 m to avoid working in the scallop fishing area during scallop fishing season as well as to avoid the lobster migration period within the RAA, if feasible. Construction will resume in October after the lobster fishing season is complete.

3.1.1.5 Residual Environmental Effects Description Criteria

Table 3.2 provides the environmental effects classification criteria that are used to characterize and describe Project residual environmental effects on the Marine Environment.

Table 3.2 Characterization of Residual Environmental Effects on the Marine Environment

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 the Marine Environment relative to baseline. **Adverse**— an effect that moves measurable parameters in a direction detrimental to the Marine Environment relative to baseline. **Neutral**—no net change in measureable parameters for the Marine Environment relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible**—no measurable change from existing baseline conditions. **Low**—a measurable change from existing baseline conditions, but is below environmental and/or regulatory thresholds and does not affect the ongoing viability of marine populations. **Moderate**—measurable change (but less than high) from existing baseline conditions that is above environmental and/or regulatory thresholds, but does not affect the ongoing viability of marine populations.

Table 3.2 Characterization of Residual Environmental Effects on the Marine Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		High—measurable change from existing baseline conditions that is above environmental or regulatory thresholds and adversely affects the ongoing viability of marine populations.
Geographic Extent	The geographic area in which an environmental, effect occurs	**PDA**—residual effects are restricted to the PDA (i.e., construction footprint associated with the submarine cables). **LAA**—residual effects extend into the LAA. **RAA**—residual effects interact with those of other projects in the RAA.
Frequency	Identifies when 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 over assessment period.
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term**—residual effect restricted to duration of construction. **Medium-term**—residual effect measurable for up to two years following completion of construction. **Long-term**—residual effect extends throughout operation of the Project.
Reversibility	Pertains to 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 after activity completion and reclamation. **Irreversible**—the effect is unlikely to be reversed.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental 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.

3.1.1.6 Significance Definition

A significant adverse residual environmental effect on the Marine Environment VC is one that causes a change in marine populations in such a way as to cause a decline in abundance or change in distribution such that the populations in the assessment area will not be sustainable.

The applicable legislation and regulations (i.e., *Fisheries Act*, *MBCA*, *SARA*, PEI *Wildlife Conservation Act* and New Brunswick *SARA*) are considered to be an essential part of the framework for the assessment of adverse residual environmental effects on marine populations.

3.1.2 Existing Conditions for Marine Environment

3.1.2.1 Methods

Baseline data and information collected during a literature review and field studies were used to characterize the baseline conditions for the Marine Environment. A review of relevant marine fish, fish habitat, wildlife and wildlife habitat data from various sources was undertaken including: previous environmental assessments; publically available reports from marine groups; and government sources (e.g., DFO, Environment Canada).

Although the review of previous studies and existing information provided some information on the Marine Environment in the Project location, and specifically at the regional and local spatial scales, it was determined additional information and data were required to support the Project assessment. In particular, sediment quality and benthic habitat data were required at the location of the submarine cables. Field studies were undertaken in fall 2014 to supplement the existing marine data. Additional field studies are planned for October 2015 to determine the current profile and water quality in the area. Results from these surveys will be provided as a supplemental report.

3.1.2.1.1 Field Methods

Field programs were conducted during fall 2014, to characterize the marine environment in the vicinity of the location of the submarine cables. Sediment samples were collected for chemical and physical analysis. Underwater video of the marine benthic habitat was collected in the nearshore area of the PDA to identify macroflora and macrofauna and to characterize the substrate. Survey methods for each program are briefly summarized below.

Sediment Quality

In October 2014, marine sediment samples were collected by divers from 10 locations throughout the PDA (see Figure 3.2 for sample locations) by Diversified Divers Inc. The program was conducted with the use of a fishing vessel, held in position by an anchor. Samples were analyzed for total organic carbon (TOC), polycyclic aromatic hydrocarbons (PAHs), total polychlorinated biphenyls (PCBs), trace metals including mercury and particle grain size.

Benthic Habitat

Nearshore underwater video was collected by divers in November 2014 on the PEI side of the Northumberland Strait and in September 2015 for the NB side (see Figure 3.2 for transect locations). The underwater transects were located approximately in the middle of the PDA to get a general overview of the habitat in the area. Lead lines, marked in 10-metre increments, were used to measure transect distances. Attempts were made to collect underwater benthic images across the Northumberland Strait using a towed video camera; however, due to the conditions during the 2014 surveys (time of year) and turbidity of the water, no quality video images were collected.

3.1.2.2 Overview

3.1.2.2.1 Physical Environment

Bathymetry

The proposed submarine cable corridor extends from Cape Tormentine in New Brunswick to Borden in PEI, encompassing a distance of approximately 16.5 km. The corridor is located to the east of the Confederation Bridge in the Abegweit Passage. A general description of the bathymetry in the area is provided by AMEC (2007) and is shown in Charts 4023 and 4406 from the Canadian Hydrographic Service.

In general, the Abegweit Passage presents gradual slopes from the shore towards a single deep channel in the middle which extends from northwest to southeast with water depths approaching 30 m. Moving further to the east the channel widens and becomes deeper at localized points (water depths near 35 m) while shallow areas (in the 10 m range) are found near both shores. Shallow areas include Baie Verte in the southwest and the Tryon Shoals in the northeast.

Canadian Seabed Research Ltd. (CSR) was commissioned for the Project to carry out a detailed bathymetric survey of the cable corridor (CSR 2015). The survey was completed in summer 2014 and included among other tasks the mapping of the sea floor using single-beam echo sounding and side-scan sonar instruments. According to CSR, the survey was designed to map 100 % of the cable corridor with the side-scan sonar (approximate width of 500 m) as well as coarse line spacing for the entire corridor and detailed line spacing over the landfall areas with the single-beam sounder.

The bathymetric survey started at approximately kilometre posting (KP) 0.7 near Cape Tormentine and extended to KP 16.2 near Borden. The minimum and maximum water depths in the cable corridor range from 2 m to 31 m (chart datum). From Cape Tormentine, a gradual slope towards the main channel is broken by a sand shoal between KP 3 to KP 4.5, which raises the sea floor to an approximate water depth of 4 m. Beyond this point, the sand shoal ends at a water depth of 18 m where the sea floor remains almost flat until KP 6.5 and where the slope then increases towards the main channel reaching water depths near 30 m. The main channel gradually decreases in depth until KP 11.5. Beyond this point there is a rise in the sea floor followed by a flat section near 15 m water depth until KP 15, at which point the slope rises again until the sea floor meets the land. Detailed bathymetric information is presented in CSR 2015.

Surficial Geology and Sediment Characteristics

Summaries of surficial geology are presented in CSR (2015) and AMEC (2007) based on previous regional studies carried out for the Northumberland Strait (Kranck 1971; Loring and Nota 1973; and Fader and Pecore 1989).

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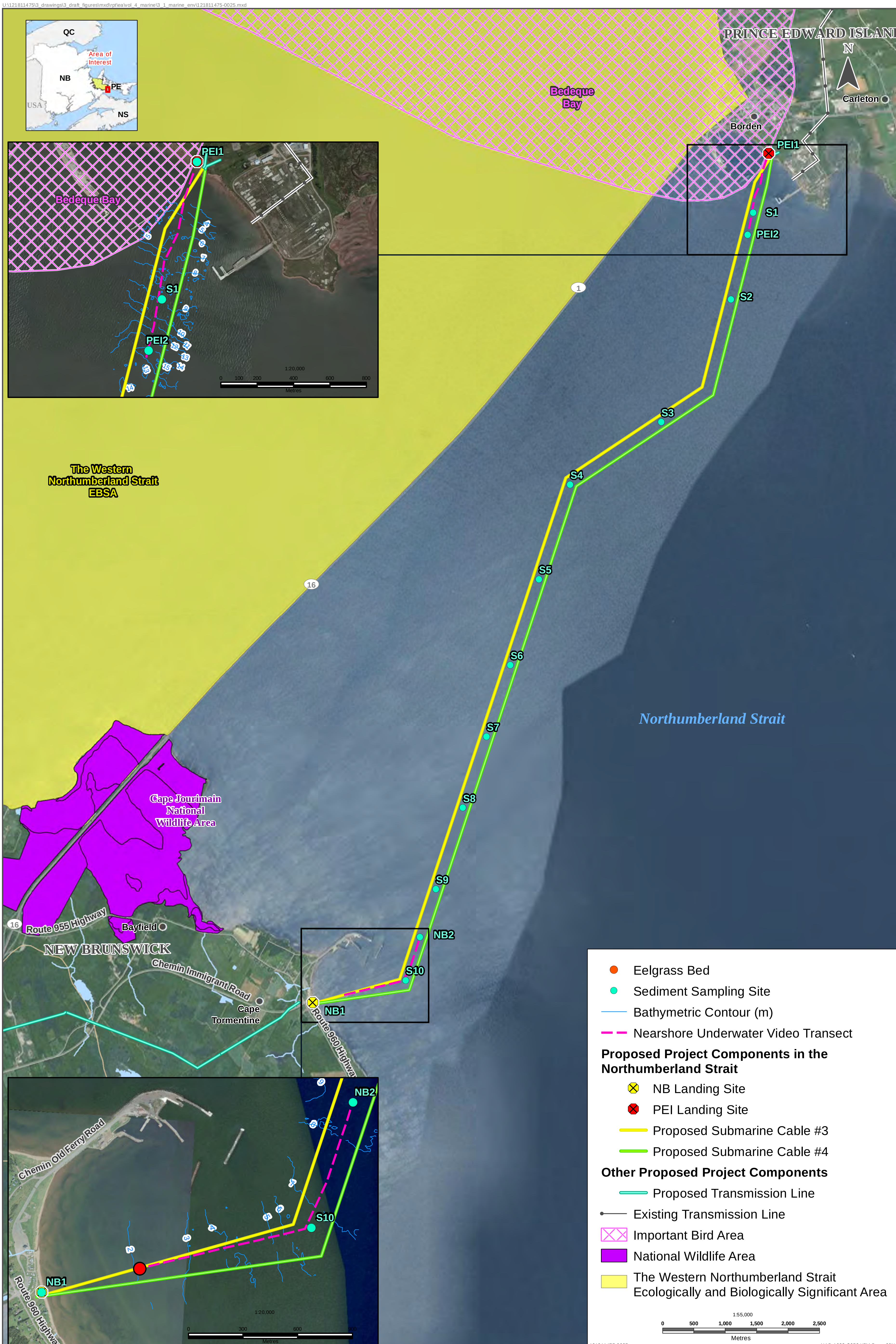

Sources: GeoNB, NB Power, PEI Government (2010), Canadian Seabed Research (2014), Surficial Geology, CHS (1972), Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Benthic Habitat Sample Locations

Figure 3.2

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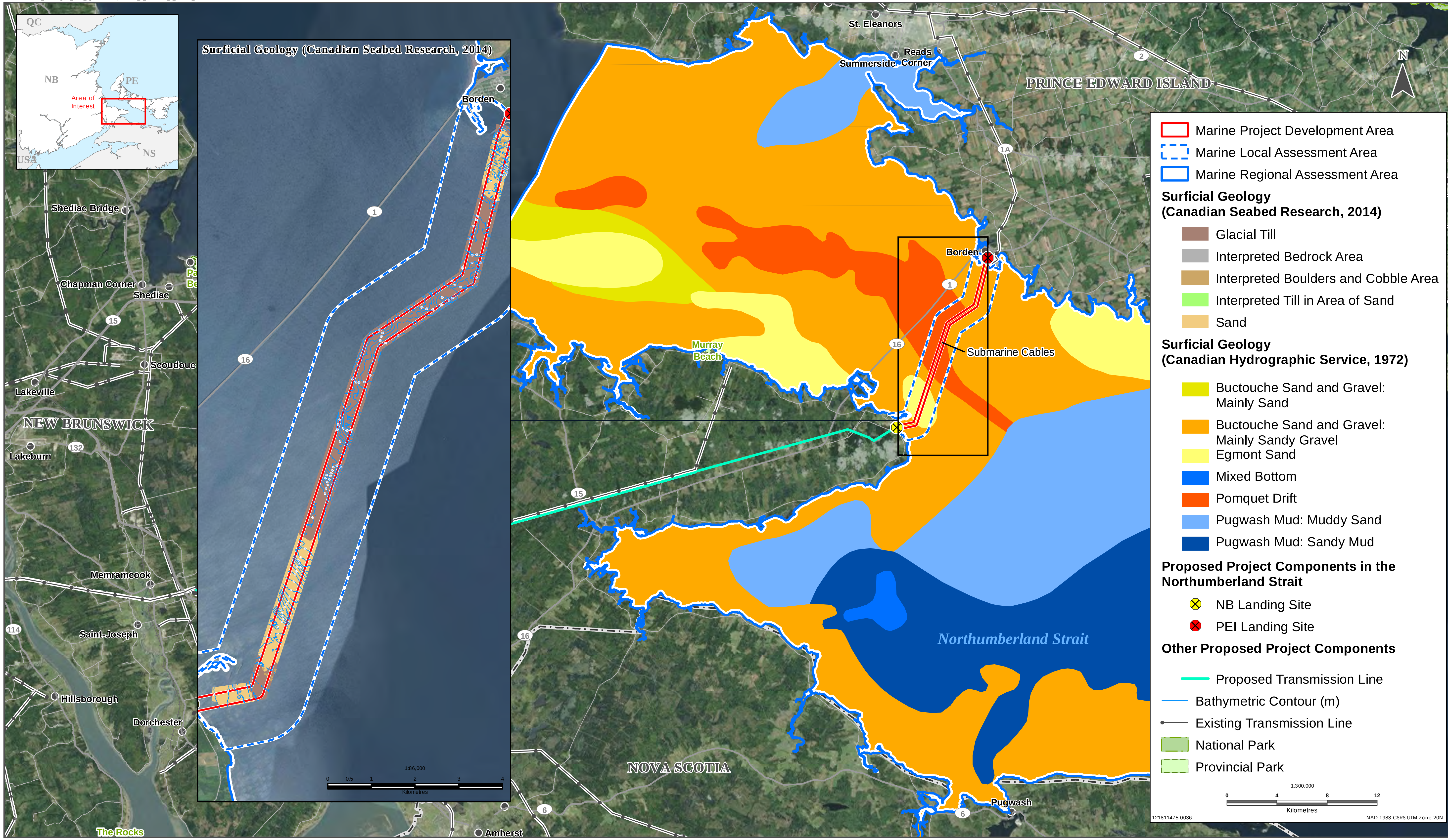

Sources: GeoNB, NB Power, Canadian Seabed Research (2014), Canadian Hydrographic Service (1972) Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Surficial Geology in the Marine Regional Assessment Area

Figure 3.3

Based on the surficial geology map generated by Kranck (1971), there are three distinctive surface geologic features within the cable corridor. These include a small pocket of Egmont Sand near Cape Tormentine, a limited band of Pomquet drift within the deeper middle channel, and an area containing Bouctouche sand and gravel which covers the remaining cable corridor. A description of each feature is included in CSR (2015) (Figure 3.3).

Egmond sands are recent deposits of well-sorted sands with particle sizes ranging from coarse to medium sand. These normally contain abundant shell material. Pomquet drift is the oldest formation in the Strait and is comprised of glacial till and can be found generally within the main deeper channel of the Strait. Finally, Bouctouche sand and gravel contain more than 5 % gravel along the cable corridor.

According to Amec (2007), the distribution of surficial sediments within the Northumberland Strait is mainly dominated by tidal energy inputs. For the Abegweit Passage, the presence of larger particle size fractions suggests higher energy inputs when compared to the wider sections of the Strait where sediments with smaller particle sizes are predominant (i.e., Pugwash mud formations).

Ten surficial sediment samples were obtained by Stantec in fall 2014 along the cable corridor to characterize the particle size distribution and chemical quality of the sediment. The samples were labelled S1 to S10, where the sample number progresses from S1 near Borden, PEI to S10 near Cape Tormentine, NB. A summary of particle size distributions for all samples and their location along the cable corridor (KP) are presented in Table 3.3.

The results of the particle size analysis for all samples indicate sand as the predominant fraction, with variable amounts of gravel and fine particles (i.e., silt and clay) along the cable corridor. These results are in agreement with the surficial geologic characteristics that are present within the corridor.

Table 3.3 Particle Size Distribution of Sediment Samples along the Cable Corridor

Sample No.	KP (km)	% Gravel	% Sand	% Silt	% Clay
S1	15.5	5.8	71	16	7.4
S2	14.0	11	80	3.6	5.7
S3	11.6	28	65	3.1	3.9
S4	9.9	19	71	4.7	5.3
S5	8.3	34	54	5.2	6.7
S6	6.8	10	85	1.5	3.6
S7	5.6	8.2	81	5.6	5.6
S8	4.4	15	77	2.8	4.9
S9	3.1	<0.1	94	2.5	3.9
S10	1.6	11	79	5.4	4.8

Tides

Tides in the Northumberland Strait follow a complex pattern, with variations in the tidal regime and magnitudes that are largely determined by tidal characteristics in the Gulf of St. Lawrence and the dimension of the Strait itself (JWEL 1995).

In the west end of the Strait the tides follow a diurnal pattern (i.e., one high tide and one low tide per lunar day). Along the east end of the Strait the tides are mixed semi-diurnal (i.e., two high tides and two low tides with different magnitudes per lunar day). This is mainly because the diurnal and semi-diurnal signals arrive at the Strait at different times. Tide magnitudes in the east near the location of the cable corridor range from 0.2 to 2.4 m (DFO 2012). Since tidal wavelengths vary with depth, main currents in the Strait reverse themselves near the shore about one hour ahead of the main channel.

Wind and Waves

Extremal analysis of wind and waves within the Strait were obtained from the results of the MSC50 Wind and Wave Reanalysis (Swail et al. 2006), which is the most recent hindcast study in the North Atlantic basin.

The hindcast approach uses numerical wind and wave models in conjunction with historical meteorological data to simulate wind and wave conditions in the region of interest. The hindcast study includes the application of statistical tools (i.e., extremal analysis) to estimate parameters of interest (e.g., wind velocities and the associated significant wave heights for a given frequency). The MSC50 wind and wave reanalysis includes an improved grid resolution of 0.5 degrees for the Atlantic Ocean, including points near the LAA.

The Grid Point 9946 (Latitude 46.2000 N; Longitude 63.7000 W; water depth 18 m) is the nearest point to the cable corridor within the MSC50 data set. This point is located approximately 1.5 km to the east from the cable corridor.

Wind and wave statistics for Grid Point 9946 are presented in Table 3.4. These values were obtained by applying a Generalized Extreme Value (GEV) statistical distribution to the hindcast data (with a total of 59 records) and including both tropical and extratropical events. The annual maximum for each year in record is selected and the GEV distribution is applied to the 59-year record (i.e., one value for each year).

Table 3.4 Significant Wave Height and Wind Speed Near the Cable Corridor for all Compass Directions

Return Period	Sectors															
	337.5-22.5		22.5-67.5		67.5-112.5		112.5-157.5		157.5-202.5		202.5-247.5		247.5-292.5		292.5-337.5	
	HS (m)	WS (m/s)	HS (m)	WS (m/s)	HS (m)	WS (m/s)	HS (m)	WS (m/s)	HS (m)	WS (m/s)	HS (m)	WS (m/s)	HS (m)	WS (m/s)	HS (m)	WS (m/s)
2	1.39	15.01	1.12	13.09	1.40	14.01	2.05	15.83	1.90	14.79	1.81	14.95	2.10	16.94	2.04	17.21
5	1.67	17.69	1.45	16.32	1.75	16.94	2.27	17.33	2.10	16.52	2.10	17.05	2.35	18.74	2.28	19.07
10	1.80	18.93	1.62	18.05	1.91	18.26	2.38	18.05	2.22	17.65	2.28	18.37	2.48	19.68	2.39	20.13
25	1.92	20.06	1.79	19.85	2.05	19.46	2.50	18.74	2.35	19.07	2.50	19.99	2.61	20.64	2.50	21.30
50	1.99	20.68	1.88	20.96	2.13	20.09	2.56	19.12	2.45	20.12	2.65	21.15	2.69	21.21	2.56	22.05
100	2.03	21.15	1.96	21.91	2.19	20.56	2.61	19.42	2.53	21.15	2.80	22.27	2.75	21.68	2.61	22.72

Notes:
HW – significant wave height.
WS – wind speed (m/s).
Sectors - portions of the entire azimuth rose and covering all directions.

Currents

Currents in the Northumberland Strait are mainly driven by tidal and wind effects and are part of the larger circulation dynamics of the Gulf of St. Lawrence. Currents in the Strait are primarily from west to east.

Data showing the variability of near-bottom and near-surface mean currents along the Abegweit Passage can be found in JWEL (1994). These include the results of measurements using an Acoustic Doppler Current Profiler (ADCP) for month-long deployments during the summer and fall of 1993. The results show predominant currents toward the southeast for both summer and fall deployments with the exception of the near-bottom currents measured during the summer, which were to the west.

As indicated in JWEL (1995), current velocities generated by tidal effects normally range between 0.5 to 1.0 m/s, while wind-generated currents typically range between 0.1 to 0.5 m/s. It is noted that during storm events, currents can reach velocities in the order of 1.8 m/s, which were measured during strong northwest winds in November 1994. Storm conditions are most prevalent in the fall and have a maximum effect on currents when winds originate from the northwest because of alignment with the Strait which in turn maximizes the length of fetch.

Ice Conditions

In an average year, ice will initially form along the coastal regions of the Magdalen Shallows and spread eastward. By mid-January, ice usually covers half of the Magdalen Shallows and by mid- February, most of the Gulf is ice-covered. In general, the ice duration has varied from 95 days around the mouth of Gaspe Bay to more than 110 days along the north coast of PEI and along the Northumberland Strait (Chassé et al. 2014).

Ice dynamics in the Northumberland Strait are well understood and summarized in CSR (2015) and DFO (2012). Normally, ice starts to develop in coastal areas of the Strait in the last week of December. By the end of December the Strait is partially covered with grey and new ice. By the first week of January the entire Strait is ice covered, with ice thickness increasing to a maximum of approximately 1 m as the winter progresses.

Usually ice concentrations begin to decrease during the third week of March near the western end of the Strait and gradually progressing towards the east. During this time, ice movement is mostly dominated by wind and tidal effects. Most of the ice in the main channel of the Strait melts by mid-April, with only coastal fast ice remaining which normally melts by the last week of April. Details regarding ice characteristics near the Confederation Bridge can be found in Thomas et al. (2010).

Ice movement can create ice ridges that are formed by the impact of ice floes with coastal fast ice. These ridges have keels that can extend to the seabed, and when transported, have the potential to create ice scour features as the advancing keel pushes sediment material to the sides.

The survey conducted by CSR (2015) included the identification and interpretation of ice scour features along the cable corridor. A total of 133 ice scour features were found during the survey. The analysis included the determination of physical features including their location, orientation, length, width, form, and depth (when possible). A detailed description of these parameters can be found in CSR (2015). With respect to bathymetry, 41 % of occurrences were found at depths between 4 and 5 m, while the majority of occurrences (83 %) were found between 4 to 8 m. This supports the observation of ice ridge formation near the shore.

In terms of ice scour orientation, the majority of occurrences were found between 120 and 140 degrees azimuth, which is aligned with the predominant currents in the Strait. Ice scour lengths were predominantly in the 10 to 70 m range (76 % of occurrences), with a few occurrences exceeding the 100-m threshold. The width of most ice scour marks was less than 4 m (81 % of occurrences). Further details regarding ice keels and their distribution in the Northumberland Strait can be found in Obert and Brown (2011).

Water Mass Characteristics

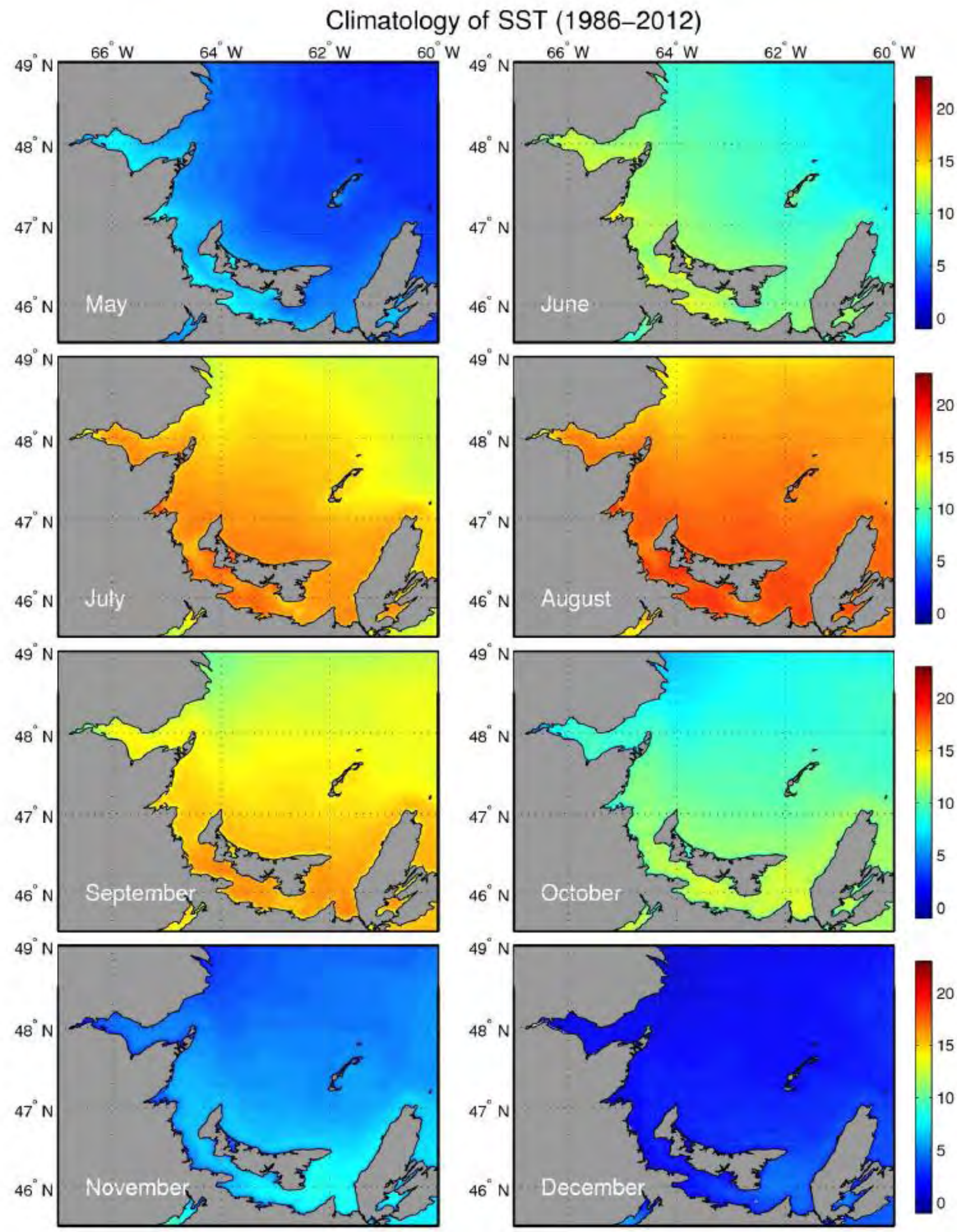
The Northumberland Strait is a long, narrow, shallow body of water located in the Southern Gulf of St. Lawrence (AMEC 2007). The water of the Northumberland Strait is primarily derived from the surface layer of the Gulf of St. Lawrence. The Gulf of St. Lawrence exhibits features of an estuarine environment due to the freshwater input of the St. Lawrence River and the deep saline flow from the Gulf Stream, entering through the Cabot Strait (AMEC 2007).

<u>Water Temperature and Salinity</u>

The average sea surface temperatures (SST) of the Northumberland Strait and the surrounding Magdalen Shallows are presented in Figure 3.4. Typically after the ice melt, sea surface temperatures begin to warm with warmer air masses and solar heating in the spring. Maximum temperatures are typically reached by August, with temperatures reaching 20 °C or greater in the Northumberland Strait. In September the surface waters begin to cool and reach minimum temperatures of -1.5 °C in the winter months before the appearance of ice (Chassé et al. 2014).

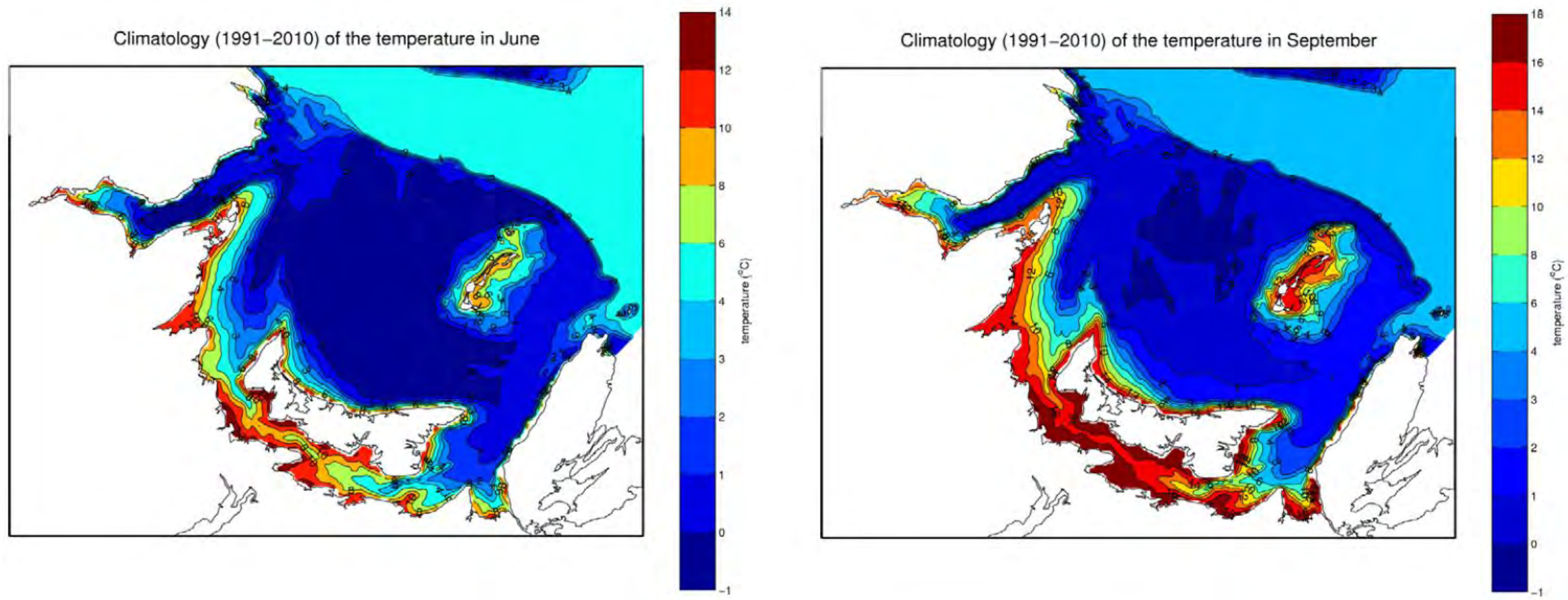
On average the warmest near-bottom water temperatures in the southern Gulf of St. Lawrence can be found in the Northumberland Strait where they can reach temperatures of >23 °C. Figure 3.5 presents the average bottom temperatures in the southern Gulf of St. Lawrence in June and September from 1991 to 2010, including the Northumberland Strait (Chassé et al 2014).

September average sea water temperature and salinity profiles for the southern Gulf of St. Lawrence can be seen in Figure 3.6. The summer warm surface layer is usually composed of waters with salinities ranging from 30 to 31 practical salinity units (psu) in the Magdalen Shallows and Northumberland Strait (JWEL 2001). From 1991 to 2010, average September bottom salinities in the Magdalen Shallows were <34 psu, with the freshest waters being observed along the coast of New Brunswick because of the influence of freshwater runoff. The average September bottom salinities in the Northumberland Strait were 28 to 30 psu. Figure 3-7 presents the average bottom salinities in September between 1991 and 2010 for the southern Gulf of St. Lawrence.



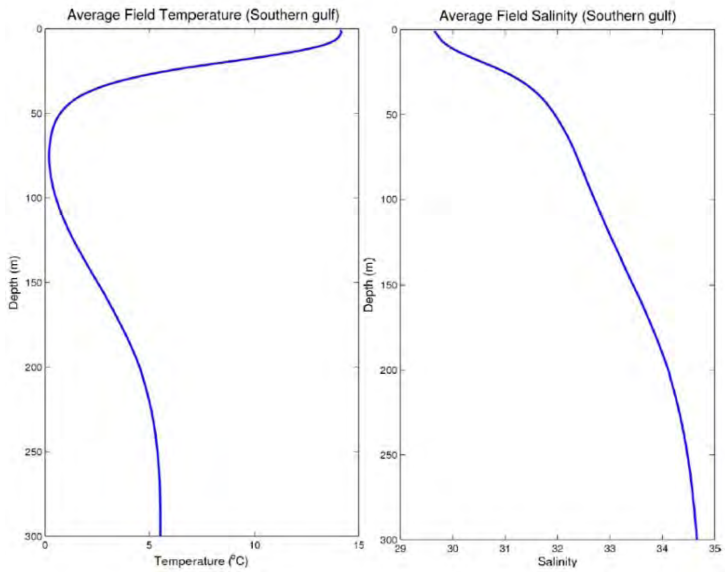
Source: Chassé et al. 2014

Figure 3.4 Sea Surface Temperature (°C) Climatology (1986 to 2012) from May to December in the Northumberland Strait and Magdalen Shallows



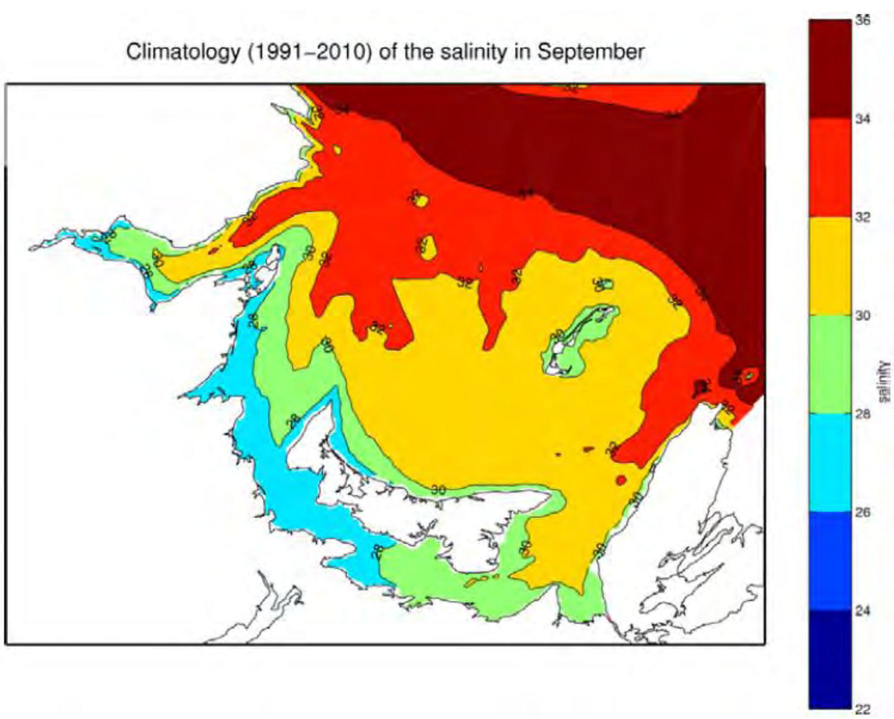
Source: Chassé et al. 2014

Figure 3.5 Average Bottom Temperatures between 1991 and 2010 in June and September for the Southern Gulf of St. Lawrence



Source: Chassé et al. 2014

Figure 3.6 Average Temperature and Salinity profiles for September (1971 to 2010) in the Southern Gulf of St. Lawrence



Source: Chassé et al. 2014

Figure 3.7 Average Bottom Salinity (psu) for September (1991 to 2010) in the Southern Gulf of St. Lawrence

3.1.2.2.2 Nearshore Benthic Habitat

Coastal habitat in the western portion of the Northumberland Strait (on the New Brunswick side) is evenly distributed between mud and sand. Organic content ranged from 1.34 to 3.28 % (Weldon et al. 2005).

Information on non-commercial benthic epifauna in the Abegweit Passage area of the Northumberland Strait is limited; the list provided in Table 3.5 was based on scallop drag samples and videotape records taken during the summer of 1988 (Hurley Fisheries 1989, in AMEC 2007).

Table 3.5 Non-Commercial Epifauna of the Abegweit Passage Area, Northumberland Strait

Group	Species	Comments/Habitat
Sand Dollars	*Echarchnius parma*	Highly abundant, often many thousands in drags over sandy areas. Distribution highly clumped and patchy.
Starfish	*Asterias sp.; Henricia snaguinolenta*	Common throughout stations. Majority of specimens tiny – nursery area?
Mussels (horse mussels)	*Modiolus modiolus*	Two dense beds off Borden and Cape Tormentine. Cobble and sand bottom, 10 to 15 m depth.
Slipper limpets	*Crepidula sp.*	On dispersed rocks in sand close to New Brunswick coast.
Clams	*Astarte sp.*	Commonly encountered.
Source: Hurley Fisheries 1989, in AMEC 2007		

The sampling of infauna from the inshore region of the Abegweit Passage has been studied in the past (Caddy et. al. 1977 and Hurley Fisheries 1989, in AMEC 2007). Samples were also collected as part of the marine environmental effects monitoring programs conducted during the construction of the Confederation Bridge from 1993 to 1995. A summary of the identification of infauna is presented in Table 3.6. The composition of species was similar amongst the various sampling programs (e.g., Maldanidae and Spionidae polychaete families were present throughout and Tellina (a clam) was reported in sandy stations). Shannon-Weiner diversity indices indicate that the benthic infauna was generally diverse (AMEC 2007).

Table 3.6 Summary of Infauna Biota in Marine Environmental Effects Monitoring Samples, 1993 to 1995

Taxa	Comments
Polychaetes	The most common group; 54 genera and/or species identified.
Other Vermiformes	Nematodes were abundant, and present throughout most samples.
Crustaceans	13 species listed including Amphipods, copepods, Gammarus spp.
Marine Spiders	3 unspecified Pycnogonid species
Molluscs	Common, particularly Tellina spp. Also two unspecified nudibranch species.
Echinoderms	Occasional
Source: AMEC 2007	

Benthic habitat surveys were conducted in the PDA in November 2014. Approximately 1,200 m of nearshore habitat perpendicular to the shore was surveyed on the PEI side of the Northumberland Strait. The substrate inshore is a mix of rock (cobble, rubble, boulder) with small amounts of sand and then transitioned to predominantly sand at approximately 350 m from shore. Hermit crabs (not identified to species) were abundant throughout the entire survey area. Periwinkles (not identified to species), Asteriid sea stars (not identified to species), sand dollars (*Echinarachnius parma*), frilled anemones (*Metridium senile*), rock crabs (*Cancer irroratus*) and unidentified fish were also observed throughout the entire survey area. Macroflora throughout the area was predominantly *Fucus* sp., sour weed (*Desmarestia* sp.), and little brown algae (*Elachistea fucicola*); eelgrass (*Zostera marina*), unidentified red algae, dulse (*Palmaria palmata*), kelp (not identified to species), wireweed (*Ahnfeltia plicata*), and unidentified brown algae were also observed, but the coverage was occasional. Unattached vegetation debris was observed throughout the entire study area.

Approximately 2,000 m of nearshore habitat perpendicular to shore was surveyed on the New Brunswick side of the Northumberland Strait. The substrate was primarily sand for the first 1,140 m then transitioned to a mixed substrate of rock (cobble with shell hache and occasional boulders) and sand for the remainder of the survey. Hermit crabs, rock crabs and sea stars were common throughout the entire survey area; unknown colonial organism and sea anemones were common in the rocky section. Additional fauna observed occasionally included unidentified fish, unidentified flounder, unidentified sponge, quahog (*Mercenaria mercenaria*) and winter skate (*Leucoraja ocellata*). Macroflora throughout the area consisted of an eelgrass bed for the first 45 m of the survey area. Occasional blades of eelgrass were observed throughout the remainder of the survey area. Once the habitat transitioned into a sand/rock mixture there was approximately 2 to 20% unidentified brown algae and occasional Fucus sp. Dulse (*Palmaria palmata*) and kelp (*Saccharina latissima*) were identified in several places but were uncommon.

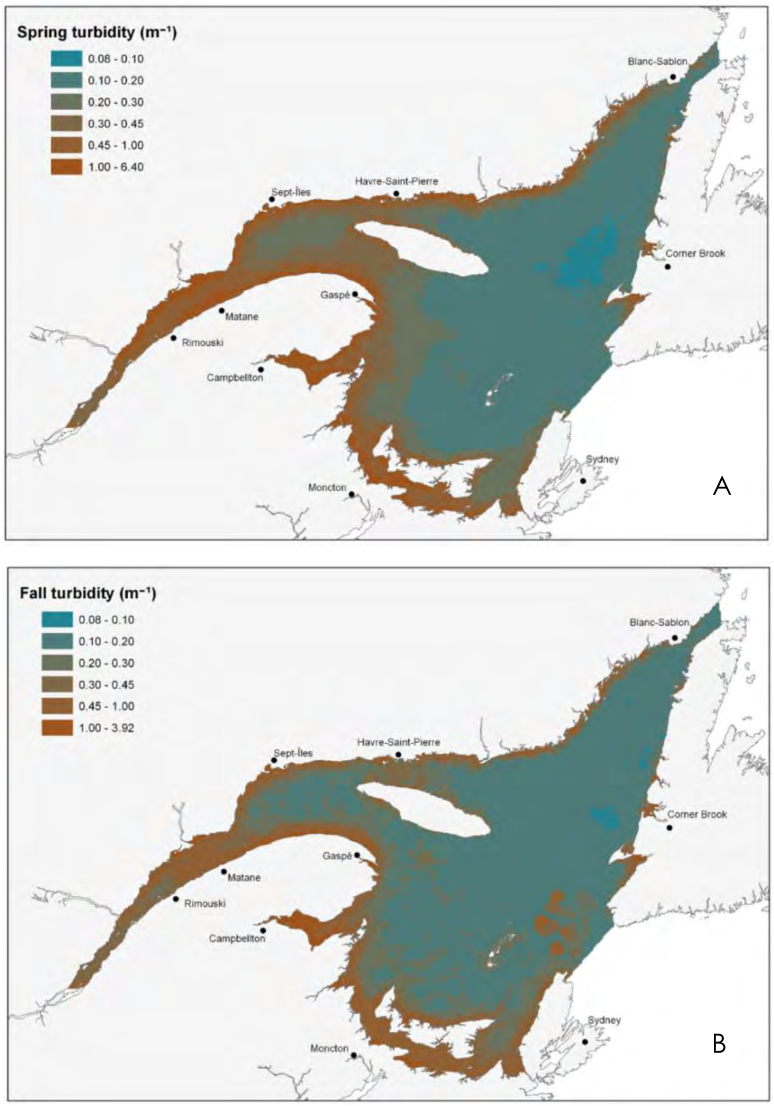
3.1.2.2.3 Water Quality

Existing water quality information in the Northumberland Strait is sparse. No site-specific water quality program was conducted in the 2014 field season, but will be taking place in October 2015. In the past, water quality was monitored for total suspended solids (TSS) and turbidity during the construction of the Confederation Bridge nearshore in PEI, in the middle of the Northumberland Strait, and in nearshore New Brunswick. The results indicate that ambient conditions are affected spatially (nearshore or mid-Strait) and temporally. Storm-induced conditions could result in a very rapid change in water quality, with the middle of the Northumberland Strait requiring a larger magnitude wind disturbance to change TSS and turbidity concentrations. The middle of the Northumberland Strait becomes stratified during the summer months (typically by June), and this influences the TSS and turbidity concentrations above and below the stratification (JWEL 1995).

The water column in nearshore PEI is well-mixed with varying TSS concentrations throughout the year; storm events and surface run-off can affect TSS levels. The TSS concentration ranged from 0 to 28.5 milligrams per litre (mg/L), with the TSS concentration increasing during the year.

The water column in the middle of the Northumberland Strait becomes stratified at varying depths, but typically at depths of 10 m or greater. The TSS concentration ranged from 2 to 19 mg/L, with the TSS concentration increasing during the year. The water column in near shore New Brunswick is well-mixed. The TSS concentration ranged from 2 to 16 mg/L, with the TSS concentration increasing during the year. After a wind and precipitation event, the TSS range increased to 14 to 27 mg/L (JWEL 1995).

Moderate resolution imaging spectro-radiometer satellite data were used by Dutil et al. (2012) to illustrate turbidity in the Gulf of St. Lawrence during the 2002 to 2011 period (Figure 3.8).

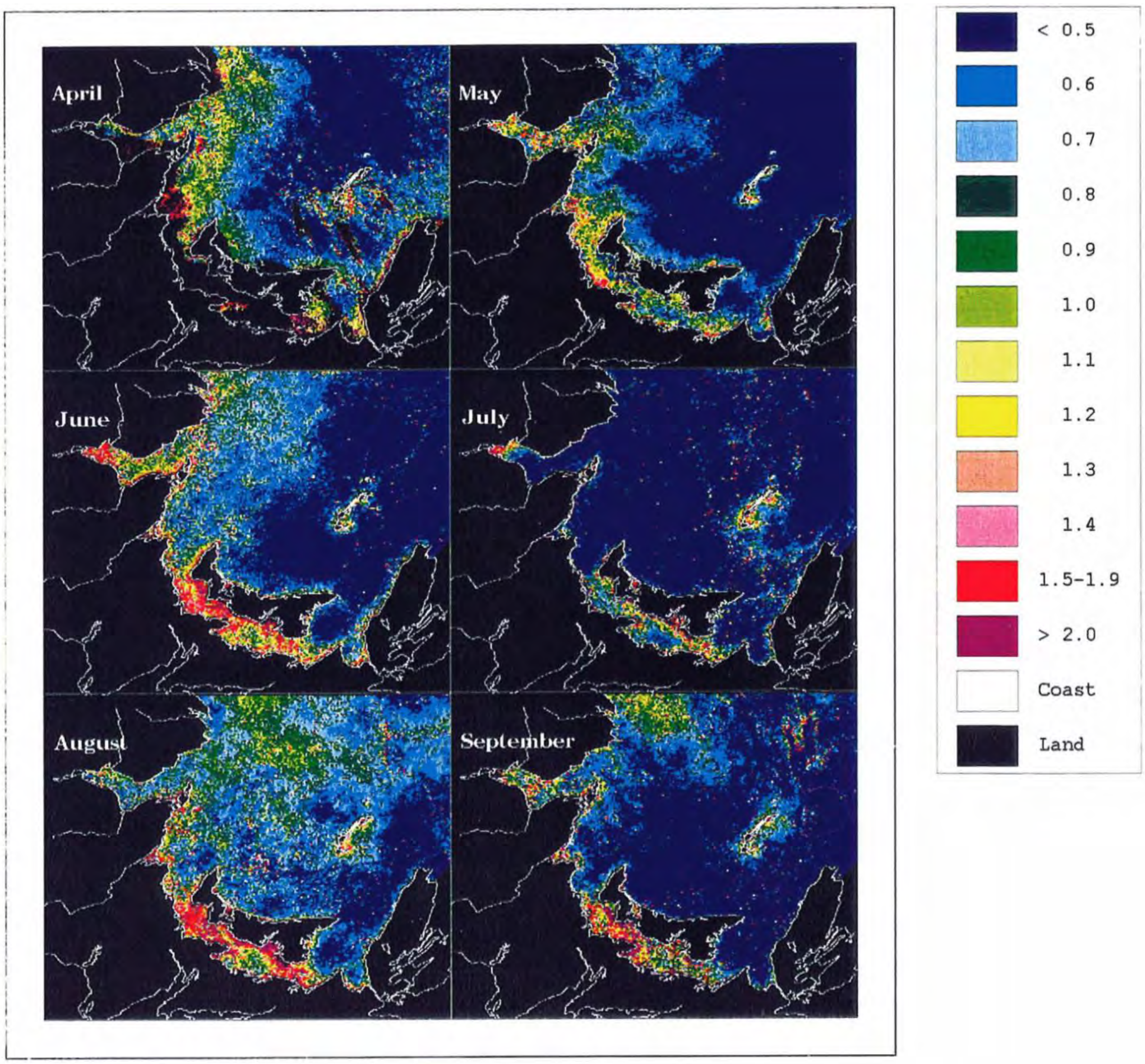


Source: Dutil et al. 2012

Note: Data were downloaded from NASA, satellite AQUA, MODIS spectro-radiometer-based estimate of the diffuse attenuation coefficient of seawater at 490 nm (m^{-1}).

Figure 3.8 Mean Turbidity in (a) Spring [April to June], and (b) Fall [October to December]

Pigment in the water is a good indicator of chlorophyll content. Fuentes-Yaco et al. (1998) studied the spatio-temporal distribution of phytoplankton pigments in Northumberland Strait using Coastal Zone Color Scanner images and in situ data collected during different periods; June, August and September indicate the highest pigment levels in the monthly composite images shown in Figure 3.9.



Source: Fuentes-Yaco et al. 1998

Figure 3.9 Coastal Zone Color Scanner Composite Images of Phytoplankton Pigments (mg/m³) from April to September (1979 to 1981) in the Southern Gulf of St. Lawrence

3.1.2.2.4 Protected and Sensitive Areas

The Western Northumberland Strait Ecologically and Biologically Significant Area

The Western Northumberland Strait Ecologically and Biologically Significant Area (EBSA) is located just west of the LAA (on the western side of the Confederation Bridge) and encompasses the western half of the Northumberland Strait between PEI and New Brunswick. The Western Northumberland EBSA is shallow (<20 m) and modelling reveals distinctive physical phenomena for the entire area including significant retention potential, tidal mixing and annual temperature cycle amplitude (DFO 2007). The area of the Gulf, in which the EBSA is situated, has the highest annual water temperature and annual temperature cycle amplitude.

The area is home to an isolated calico crab population which persists in the area and spends its entire life cycle here (DFO 2007). A large population of winter skate (half of their total population) can be found in the area in the summer and early fall. The winter skate is listed as endangered by COSEWIC. Several other ground fish species with a limited range can be found with large populations in the area, including the white hake and windowpane flounder. Giant scallop beds can be found in the area. The area represents a well-known significant area for seals (DFO 2007).

Bedeque Bay Important Bird Area

The Bedeque Bay Important Bird Area (IBA) is located on the south shore of western PEI, near Summerside. The IBA is approximately 361 km^2 and includes many marshes and mudflats. Bedeque Bay has been designated as an IBA due to its importance as a staging area during spring and fall migration. Many species of geese, ducks and shorebirds can be found making use of the area (IBA Canada 2015).

Cape Jourimain National Wildlife Area

The Cape Jourimain National Wildlife Area was designated in 1980 as a conservation site because of the diversity of waterfowl and shorebirds that use the sites marshes and shores as a staging area during spring and fall migration. Along with staging areas, there are readily available breeding habitats for waterfowl, some species of shorebirds and many species of songbirds (Cape Jourimain Nature Centre 2015).

3.1.2.2.5 Sediment Quality

A sediment sampling program was conducted along the cable route in October 2014; 10 stations (S-1 to S-10) were sampled (Figure 3.2). The route is predominantly sand with higher silt and clay content near PEI. The organic carbon content in the sediment is consistent along the route, ranging from 1.4 to 2.6 milligrams per kilogram (mg/kg).

The samples were analyzed for trace metals, PAHs, PCBs and DDT. All samples were below the reportable detection limit (RDL) for PCB and DDT. Most samples were less than the RDL for PAHs with the exception of the two sample locations closest to the New Brunswick coast (S-9 and S-10). The location closest to the New Brunswick coast (S-10) contained fluoranthene and pyrene, while location S-9 contained fluoranthene and pyrene, as well as benzo(*a*)anthracene, benzo(*a*)pyrene and benzo(*a*)fluoranthene. All samples were lower by an order of magnitude than the available Canadian Interim Sediment Quality Guidelines (ISQG) for PAHs (Canadian Council of Ministers of the Environment [CCME] 2015).

Of the 27 metals analyzed, 11 were below the RDLs (antimony, beryllium, bismuth, boron, cadmium, mercury, molybdenum, selenium, silver, thallium and tin) and 16 were above the RDLs (aluminum, arsenic, barium, chromium, cobalt, copper, iron, lead, lithium, manganese, nickel, rubidium, strontium, uranium, vanadium and zinc) (Table 3.7). None of the metals above the RDL with an ISQG (arsenic, chromium, copper, lead and zinc) exceeded the ISQG limit. The two metals with *CEPA* Disposal at Sea Sediment Screening Criteria (lower level) limits (cadmium and mercury) were not detected in any sediment sample.

Table 3.7 Total Extractable Metals along Cable Route, October 2014

Parameter	RDL	Units	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	CEPA Disposal at Sea Screening Criteria - Lower Level	CCME Sediment Quality Guidelines	
														ISQG[1] Marine	PEL[2] Marine
Aluminum	10	mg/kg	4,600	3,600	4,100	3,700	4,100	4,400	4,800	4,400	4,800	4,500		-	-
Antimony	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2		-	-
Arsenic	2	mg/kg	2	5	3	3	7	7	5	5	4	3	-	7.24	41.6
Barium	5	mg/kg	21	10	14	12	13	13	13	14	17	19	-	-	-
Beryllium	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	-
Bismuth	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	-
Boron	50	mg/kg	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	-	-
Cadmium	0.3	mg/kg	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.6	0.7	4.2
Chromium	2	mg/kg	12	9	10	9	10	10	11	10	10	10	-	52.3	160
Cobalt	1	mg/kg	5	4	4	5	5	5	5	4	5	4	-	-	-
Copper	2	mg/kg	4	3	3	3	3	2	2	2	2	3	-	18.7	108
Iron	50	mg/kg	12,000	11,000	11,000	10,000	12,000	13,000	14,000	13,000	12,000	13,000	-	-	-
Lead	0.5	mg/kg	4.8	4.6	5.2	4.8	5.8	5.1	5.4	5.3	4.4	8.5	-	30.2	112
Lithium	2	mg/kg	13	9	10	9	10	10	11	11	12	11	-	-	-
Manganese	2	mg/kg	170	250	220	220	720	280	250	270	350	230	-	-	-
Mercury	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.75	0.13	0.7
Molybdenum	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	-
Nickel	2	mg/kg	10	7	8	8	9	8	9	8	9	9	-	-	-
Rubidium	2	mg/kg	4	3	3	3	3	3	4	3	4	4	-	-	-
Selenium	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-
Silver	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-
Strontium	5	mg/kg	10	33	32	44	120	25	12	23	13	15	-	-	-

Table 3.7 Total Extractable Metals along Cable Route, October 2014

Parameter	RDL	Units	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	CEPA Disposal at Sea Screening Criteria - Lower Level	CCME Sediment Quality Guidelines	
														ISQG[1] Marine	PEL[2] Marine
Thallium	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-
Tin	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	-
Uranium	0.1	mg/kg	0.5	0.3	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.5	-	-	-
Vanadium	2	mg/kg	22	20	21	19	22	23	23	24	18	26	-	-	-
Zinc	5	mg/kg	21	22	22	21	24	26	28	25	24	23	-	124	271

Notes:

[1] ISQG – Interim Sediment Quality Guidelines as specified in the (Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environmental, 1999, updated 2015).

[2] PEL – Probable Effect Levels as specified in the (Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environmental, 1999, updated 2015).

Analytes detected at or above RDL are reported here.

3.1.2.2.6 Marine Fish

Many marine fish species targeted as CRA fisheries occur in the RAA. The main CRA fisheries are American lobster (*Homarus americanus*), deep-sea scallop (*Placopecten magellanicus*) and rock crab (*Cancer irroratus*). Groundfish in the RAA include Atlantic cod (*Gadus morhua*) and Atlantic halibut (*Hippoglossus hippoglossus*). Pelagic species fished commercially include Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*).

Shellfish species likely dominate the Aboriginal and recreational fisheries, including bar clams (Atlantic surf clam, *Spisula solidissima*), soft-shell clams (*Mya arenaria*), blue mussels (*Mytilus edulis*) and eastern oysters (*Crassostrea virginica*).

There are no marine fish species at risk listed under Schedule 1 of *SARA* found within the RAA. COSWEIC-assessed marine fish species that could occur in the RAA include Atlantic salmon (*Salmo salar*) (Gaspé-Southern Gulf of St. Lawrence population), smooth skate (*Malacoraja senta*) (Laurentian-Scotian population) and thorny skate (*Amblyraja radiate*) (Species at Risk Public Registry 2015).

A brief description of the dominant CRA fishery species in the RAA with the potential to occur in the PDA and LAA is provided in the following sections.

American Lobster

American lobster can be found in shallow subtidal waters to the edge of the continental shelf from North Carolina to Labrador, in water temperatures ranging from -1 °C to 26 °C, with a preferred temperature of 4 °C to 18 °C (Chassé et al. 2014). Lobsters prefer rocky areas and have been known to inhabit sand, gravel and mud bottoms and migrate between deeper offshore waters in the winter and shallower waters in the summer (DFO 2009a).

The reproductive cycle of the female American lobster lasts approximately two years (DFO 2013a). Female lobster mate with a male once molting is complete; the sperm are stored on the underside of its body in a "sperm plug". This initiates an approximately two-year reproductive cycle, with eggs developing internally over a 12-month period, extruded the following summer then fertilized with the stored sperm (DFO 2009a, 2013a). The female then carries the fertilized eggs attached under her abdomen for an additional 9 to 12 months before they hatch. Once hatched, the larvae are planktonic for three to ten weeks, depending on temperature (DFO 2013a). The larvae then settle to the bottom and find suitable shelter to inhabit in the benthic environment; the juvenile lobsters prefer inshore gravel/cobble substrates with kelp cover (Christian et al. 2010).

Juvenile and adult lobsters are omnivorous predators, feeding on species such as gastropods (periwinkle), bivalves such as mussel, crustaceans (rock crab are an important prey item), polychaetes, sea stars, sea urchins, fish and plant material (DFO 2009a, 2013a; Christian et al. 2010). Lobsters have been known to scavenge for food and feed opportunistically on dead animals including fish, marine mammals and discarded bait and on discarded lobster shells (DFO 2009a). Adult lobsters are fed on primarily by humans (DFO 2009a). While it is suggested that small lobster are prey for several fish (such as cod, flounder, sculpin (species dependent upon region)), a study by Hanson (2009) examining the stomachs of 14 demersal fish, 5 pelagic fish and 3 crustacean species, indicated that planktonic lobster larvae were rarely preyed upon, and juvenile lobster predation (during the molt) was restricted to shorthorn sculpin and adult lobster.

Deep-sea Scallop

The deep-sea scallop is a large bivalve mollusc found from North Carolina to Labrador in depths ranging from approximately 10 to 100 m (but may be found in shallower areas) and 15 to 37 m in the RAA (DFO 2011). They are benthic filter-feeders that frequently occur on sand-gravel or gravel-pebble substrates in dense local aggregations (DFO 2011).

Sea scallops are typically between 100 to 150 mm in shell height and annual rings are formed on the shell each year at the time of cold water (DFO 2011; Davidson et al. 2012). The ideal temperature for growth is 13.5 °C (typically ranging from 8 °C to 18 °C); mortality occurs at temperatures of 23.5 °C or higher. Sea scallop growth rates are highly variable (DFO 2011). Scallops sampled and aged during an at-sea program in the southern Gulf of St. Lawrence, conducted between 2001 to 2005, ranged from 3 to 17 years old (DFO 2011).

Sea scallop typically reach shell heights of 100 to 150 mm (Davidson et al. 2012). Sea scallop can spawn once they reach a shell height >70 mm; fecundity varies annually and is exponentially related to the shell height (DFO 2011). Timing for spawning varies from July to early October (Christian et al. 2010) and typically occurs at the end of August in the RAA, with egg and sperm released simultaneously (DFO 2011). The planktonic larvae metamorphose and settle to the bottom after four to five weeks (DFO 2011); however, settlement (and metamorphosis) can be delayed for approximately one month in the search for suitable substrate (Christian et al. 2010).

Adult scallop filter the water column for plankton and detritus. In addition to humans, adult sea scallop are fed upon by lobster, rock crab, sea star, moon snails, burrowing anemones and fish such as cod, plaice, wolffish, sculpins and winter flounder (Christian et al. 2010).

Rock Crab

Rock crab are found from Labrador to Florida (Christian et al. 2010) on all bottom types to a depth of 575 m, although they are found primarily in intertidal areas north of Cape Cod (Gosner 1978) and prefer sandy bottoms in shallow waters (DFO 2013b). The southern Gulf of St. Lawrence population is widespread and abundant (DFO 2013b; Caddy and Chandler 1976, in Rondeau et al. 2014) and is most abundant on seaweed-covered rocky substrates, but they can occur in eelgrass beds and bare rocky or sandy substrates (Christian et al. 2010).

Female rock crab mate with a male in late summer and fall once molting is complete and the female's carapace is still soft. Eggs are not stored but are typically extruded and fertilized soon after mating; eggs are then carried beneath the female's abdomen for approximately 10 months. Once hatched (occurring as early as mid-June), the larvae are pelagic and go through six stages before they settle to the substrate, typically by mid-September (DFO 2013b).

Rock crabs feed on polychaetes, other crustaceans, bivalves (including sea scallop and mussel), sea urchin and brittlestar (JWEL 2001; Christian et al. 2010). Rock crab is a key food item for lobster (DFO 2013a) and are also eaten by groundfish (Christian et al. 2010).

Atlantic Cod

There is no directed commercial fishery for Atlantic cod (*Gadus morhua*); the directed commercial fishery in the southern Gulf of St. Lawrence was closed in 2009. A set amount (300 tonnes [t] in 2012) is allocated to cover Atlantic cod by-catches in other groundfish fisheries, negotiated Aboriginal food, social and ceremonial agreements, a limited recreational fishery, and for scientific purposes (DFO 2012a).

Atlantic cod occur on both sides of the North Atlantic, from southern Baffin Island to North Carolina, preferring temperatures of -0.5 °C to 10 °C and occurring to depths of 450 m (Scott and Scott 1988). Southern Gulf of St. Lawrence Atlantic cod are migratory.

The Atlantic cod start to mature at ages four to five, reaching sexual maturity by age seven (DFO 2009b). Spawning occurs from late April to early July around the Magdalen Islands and in the Shediac Valley at depths influenced by temperature (Scott and Scott 1988; DFO 2009b). Eggs and sperm are released by the adults and fertilization occurs in the water column. Atlantic cod eggs develop near the surface; hatching occurs when the embryos are approximately 3 to 6 mm long and is dependent upon water temperature. The larval Atlantic cod remain pelagic until they are approximately 25 to 50 cm long, at which time they then descend (Scott and Scott 1988).

Atlantic cod feed primarily on the bottom on krill, shrimp, and small fish; however, they may also feed in the pelagic zone. Atlantic cod begin to migrate in late October, overwintering along the edge of the Laurentian Channel. They typically migrate back into the RAA beginning in mid-April (DFO 2009b).

Atlantic Halibut

In the Northwest Atlantic, Atlantic halibut live from Virginia to Labrador (and Greenland), in waters greater than 2.5 °C (Scott and Scott 1988). The Gulf of St. Lawrence stock is one of two in eastern Canada, the other is the Nova Scotia and southern Grand Banks stock. Gulf of St. Lawrence Atlantic halibut migrate between shallower water during the summer and waters as deep as 500 m in the winter; they prefer to remain in the area where they were born (DFO 2009c).

Gulf Atlantic halibut spawn from December to January and May to June. Spawning females are typically between 10 and 14 years old; sexually mature males are typically 8 to 10 years old (DFO 2009c, 2015). The Magdalen Shallows are likely a favourable spot for spawning in the Gulf of St. Lawrence (DFO 2009c). Spawning takes place at water depth of approximately 185 m or greater; the eggs remain pelagic and hatch in approximately 16 days (at 6 °C) (DFO 2009c). The larvae remain pelagic for some undefined period (the yolk sac lasts four to five weeks), but gradually settle to the bottom (Scott and Scott 1988; DFO 2009c).

The diet of the Gulf Atlantic Halibut stock, as determined from stomach contents collected between May and November, is comparable to that described elsewhere in the Atlantic Ocean. In the Gulf of St. Lawrence, invertebrates such as krill and shrimp are the primary food of Atlantic halibut less than 30 cm. Atlantic halibut between 30 and 80 cm can feed on fish and shellfish such as capelin, witch flounder, sculpin, snow crab and squid, among others (DFO 2015).

Atlantic halibut are not typically harvested in the Northumberland Strait RAA (DFO 2015).

Atlantic Herring

In the Northwest Atlantic, Atlantic herring live from North Carolina to Labrador (and Greenland) (Scott and Scott 1988) and are found from the north shore of the Gaspe Peninsula to the northern tip of Cape Breton Island (including the Magdalen Islands) in the in the southern Gulf of St. Lawrence (LeBlanc et al. 2015).

Atlantic herring are a pelagic species, forming schools during feeding and spawning periods. Spawning occurs in the spring (April and May, with some in June in the Northumberland Strait and Chaleur Bay) and fall (mid-August to mid-December in Miscou and Escuminac, New Brunswick; North Cape and Cape Bear, PEI; and Pictou, Nova Scotia) at depths <10 m and 5 to 20 m, respectively (DFO 2014). The eggs and sperm are released simultaneously and remain attached (usually on seaweed) on the bottom until hatching. Eggs spawned in the spring hatch in approximately 30 days, and those spawned in the fall hatch in approximately10 days. Atlantic herring larvae are planktonic and feed on small phytoplankton (JWEL 2001). Adults overwinter off the east coast of Cape Breton, Nova Scotia (LeBlanc et al. 2015).

The primary food source for Atlantic herring is plankton (copepods, euphausiids, fish eggs, pteropods and mollusc and fish larvae) (DFO 2014; LeBlanc et al. 2015).

Atlantic Mackerel

Atlantic mackerel are a pelagic species occurring from North Carolina to the Gulf of St. Lawrence and the east coast of Newfoundland (Scott and Scott 1988). Atlantic mackerel migrate into the Gulf of St. Lawrence in the spring and back into the Atlantic Ocean and deeper, warmer waters at the edge of the continental shelf between September and November (DFO 2012b). Atlantic mackerel are a schooling species and move in large schools (JWEL 2001).

Atlantic mackerel primarily spawn in two areas in the Northwest Atlantic Ocean: between Cape Hatteras and Cape Cod; and in the southern Gulf of St. Lawrence, with limited spawning occurring off the coasts of Newfoundland and Labrador or Nova Scotia (Scott and Scott 1988). The key spawning area is the Magdalen Shallows (Scott and Scott 1988). The main Atlantic mackerel stock spawn in the Northumberland Strait in June and July (DFO 2012b). Female Atlantic mackerel spawn several times during the spawning season at any time of the day and night. Water temperature determines egg development time, with eggs hatching in five to seven days at 11 °C to 14 °C. Larvae are common in the Magdalen Shallows, north of the RAA and measure approximately 3 mm long at hatching; they are considered juveniles at 50 mm in length and begin to form schools (JWEL 2001).

Atlantic mackerel feed primarily on plankton (via filter feeding); however, adults feed on small fish and squid (Scott and Scott 1988; JWEL 2001).

Bar Clams

Bar clams range from Rhode Island to Baffin Island in the Western North Atlantic at water depths from just below the low water mark to approximately 100 m on sandy substrates (Gosner 1978; DFO 1996a, 2010a).

Bar clams in PEI reach sexual maturity at approximately four years (80 to 95 mm shell length) and spawn from late June to August at temperatures greater than 15 °C (Cargnelli et al. 1999; Christian et al. 2010). Fertilization occurs in the water column and the fertilized eggs and larvae are planktonic, settling to the bottom as they become juveniles (occurring approximately 20 to 35 days after fertilization, temperature-dependent) (Cargnelli et al. 1999). They can grow to shell lengths of 175 mm. Bar clams typically burrow 2 to 3 cm into the substrate and can move across the substrate using its muscular foot (DFO 1996a).

Bar clams siphon plankton (primarily diatoms and ciliates) from the water column. In addition to humans, adult bar clams are fed upon by snails, sea stars, crab, and fish including haddock and cod (Cargnelli et al. 1999; Christian et al. 2010).

Soft-shell Clam

Soft-shell clams occur from North Carolina to Labrador in the Western North Atlantic on mud or sand flats in shallow waters, from the intertidal to approximately 9 m. They are an important commercial, recreational and traditional species in the Gulf of St. Lawrence (Gosner 1976; Abgrall et al. 2010).

Spawning typically occurs between early to late June and early July in the southern Gulf of St. Lawrence (DFO 1996b, 2001), with males releasing sperm first into the water column, followed by females releasing eggs (DFO 1996b; Abgrall et al. 2010). The fertilized eggs metamorphose through various stages, first free-swimming larvae (approximately four weeks), then settling to the bottom and exploring the substrate as juveniles. The juveniles gradually lose their mobility and develop into sedentary adults, building a permanent burrow at approximately 6 mm in size (DFO 1993, 1996b; Abgrall et al. 2010).

Soft-shell clam siphon microscopic plant and animal material from the water just above the substrate surface (DFO 1993). In addition to humans, adult soft shell clams are fed upon by starfish, birds (such as sea ducks and shorebirds), worms, crustaceans (such as crabs), fish (such as rays and flounders) and other molluscs (such as moon snails) (DFO 1993; Abgrall et al. 2010).

Blue Mussel

Blue mussels occur attached to submerged surfaces from South Carolina to Baffin Island in the Northwest Atlantic Ocean (Gosner 1976; DFO 2003; Christian et al. 2010). Blue mussels spawn in the warmer months (May to August), with male and female releasing their gametes synchronously (DFO 2003; Christian et al. 2010). The fertilized eggs metamorphose through various stages, first free-swimming larvae for three to four weeks, then settling to the bottom and exploring the substrate as juveniles. The juveniles gradually lose their mobility and develop into sedentary adults, attaching to a hard substrate with byssal threads (DFO 2003; Christian et al. 2010).

Mussels are suspension feeders, actively filtering phytoplankton cells (both living and dead) from the water through the frilled siphons; they also ingest decomposed macrophytes or re-suspended detritus and bacteria (DFO 2003; Christian et al. 2010). In addition to humans, adult blue mussel are fed upon by sea ducks, starfish, crabs, lobster and oyster thief (DFO 2003); they are the most important food item for the common eider (Christian et al. 2010).

Eastern Oyster

The eastern oyster (known as American oyster) can be found on hard substrate from Brazil to the Gulf of St. Lawrence (Comeau et al. 2008), with large concentrations in Chesapeake Bay and off the coast of the Gulf of Mexico (DFO 2010b).

Spawning In the southern Gulf of St. Lawrence is dependent upon water temperatures and occurs from late June to early July (mid-June to August in the Maritimes) (DFO 2009d; Abgrall et al. 2010). Eggs and sperm are synchronously released into the water column (individual eastern oyster can alternate sexes during a spawning season) (Galtsoff 1964, in Abgrall et al. 2010). The fertilized eggs metamorphose through various stages, first free-swimming larvae, then settling to the bottom and attaching itself to a hard substrate with a cement secretion (DFO 2009d; Abgrall et al. 2010).

Adult eastern oyster are suspension filter-feeders, ingesting various sizes of phytoplankton, bacteria, and particles from the surrounding water (Abgrall et al. 2010). In addition to humans, adult Eastern oyster are fed upon by crabs, sea stars, flatworms and birds such as sea ducks and oystercatchers (Gosner 1976; Abgrall et al. 2010).

3.1.2.2.7 Marine Wildlife

Marine Reptiles

The only marine reptile that has been observed in Northumberland Strait is the leatherback sea turtle (*Dermochelys coriacea*). This is the most widely distributed and largest of all marine turtle species, and will undertake annual migrations into Atlantic Canadian waters during the summer months. The main reason for the turtle's migration into Northern Atlantic waters is to feed on jellyfish, which are seasonally abundant in temperate shelf and slope waters off of Eastern Canada. A report by DFO (2011) identified the southeastern portion of the Gulf of St. Lawrence as a primary area of important habitat. While there is no known concentration of leatherback turtles that occurs directly in the Northumberland Strait, turtles do pass through the Abegweit Passage (AMEC 2007). The leatherback turtle is a listed species under Schedule 1 of *SARA*.

Marine Mammals

The Gulf of St. Lawrence provides habitat for a number of marine mammal species, including 13 recorded species of whales and four species of seals (DFO 2005). Within the Northumberland Strait there are nine species of marine mammals that have been recorded, ranging from common sightings to a rare stranding of a sperm whale (*Physeter macrocephalus*) in 1993 (AMEC 2007). These marine mammal species and frequency of occurrence are provided in Table 3.8. Out of the nine marine mammal species that have been known to occur in the Northumberland Strait, the Fin Whale (*Balaenoptera acutorostrata)* is the only mammal that is listed under Schedule 1 of *SARA*.

Table 3.8 Marine Mammal Occurrence in the Northumberland Strait

Common Name	Scientific Name	Frequency
Grey Seal	*Halichoerus grypus*	Common
Harbour Seal	*Phoca vituline*	Common, spring, summer and fall; year-round resident in the Gulf of St. Lawrence
Hooded Seal	*Cystophora cristata*	Occasional
Harp Seal	*Phoca goenlandica*	Occasional
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Common, summer and autumn
Harbour Porpoise	*Phocoena phocoena*	Common, summer and autumn
Fin Whale*	*Balaenoptera acutorostrata*	Occasional, rare sightings
Pilot Whale	*Globicephala melaena*	Rare sightings
Sperm Whale	*Physeter macrocephalus*	Stranding occurred, Hillsborough Bay

Note: * Listed under *SARA 2002* as a special concern species.
Source: AMEC 2007

Pinnipeds

Grey seals (*Halichoerus grypus*) are ubiquitous throughout the Gulf of St. Lawrence, and one of the most common species of seal found year-round within the Northumberland Strait. Males can reach lengths up to 2.3 m long and weigh 300 to 350 kg, while females grow to a length of approximately 2 m and weigh 150 to 200 kg (JWEL 2001). Typical breeding season for the grey seal starts around late December to early February. Pups are nursed for a couple of weeks and then weaned from their mother (DFO 2015). Grey seals typically feed on herring, flounder, cod, shrimp, mackerel and a variety of other marine organisms. This variable diet makes grey seals a threat to the commercial fishery both for a reduction of resources and to damage of fishing equipment (JWEL 2001). The grey seal population in the Gulf has increased over the past 20 years; in 1999, COSWEIC designated this population not at risk. In 2014, the North Atlantic population (including pups) was estimated to be approximately 505,000 (DFO 2015).

Harbour seals (*Phoca vituline*) are another common species found in the Strait and throughout the Gulf of St. Lawrence. Males will grow between 1.4 to 1.9 m and weigh 70 to 130 kg, with females being slightly smaller (JWEL 2001). This species typically breeds in late spring to early summer (May to June) and their normal whelping locations are located in aggregations around PEI and the western shore of Cape Breton. Females reach reproductive maturity between three and five years, and will give birth to a single pup. The pup is nurtured for about a month and then weaned (JWEL 2001). Harbour seals have a highly variable diet that can consist of cod, pollock, capelin and squid. Harbour seals have one of the smallest populations among seal species found in the Gulf of St. Lawrence. In 1970 the population was estimated at 12,700 individuals; this was mainly attributed to a bounty hunt program that reduced the population substantially (JWEL 2001). However, now it is estimated that there are approximately 20,000 to 30,000 individuals in Atlantic Canada. In 2007, COSEWIC designated the harbor seal as a not-at-risk species (DFO 2015).

Hooded seals (*Cystophora cristata*) are spotted seasonally in the Northumberland Strait, typically during their breeding period in the winter. There are two major populations of hooded seals, the Greenland population and the Northwest Atlantic population. The majority of the Northwest Atlantic population typically resides in continental shelf waters off of Northern Newfoundland and Southern Labrador. However, there is a small group of seals that occupy the southern Gulf of St. Lawrence from the fall until spring, and will whelp on pack ice during March between the Magdalen Islands and PEI (Hammill et al. 2001). The nursing period for hooded seals is much shorter than other seal species, only four days, in which the pups double in size. The diet of the hooded seal is much the same as other seal species in the Gulf, consisting of a variety of pelagic fish and squid (JWEL 2001). Male seals average approximately 2.6 m in length and weigh 300 to 460 kg, while females average 2 m in length and 145 to 300 kg. The last population estimate in 2005 reported approximately 593,500 individuals, and it is thought that this number is increasing. This species is not at risk according to COSEWIC (DFO 2015).

Harp seals (*Phoca goenlandica*) are the most abundant species of seals in the Northwest Atlantic, with an estimated population of 7.4 million individuals (DFO 2015). Male and female harp seals are similar in size and average 1.6 m in length and weigh 130 to 150 kg. Harp seal breeding season is usually between February and March, with female seals giving birth to one pup per year. The pups are then nursed for approximately 12 days before weaning. The population range is restricted to the North Atlantic and divided into three sub-populations, with the Gulf herd breeding on ice near the Magdalen Islands. The success rate of breeding for harp seals depends on the ice conditions from year to year. While 2014/2015 was a good year for ice conditions and juvenile survival, the total amount of ice present in the Gulf in 2009/2010 was the lowest since 1969. This lead to very little pupping observed in the Gulf, with no whelping concentrations observed in the Southern Gulf due to the lack of ice present (Stenson and Hammill 2012). A study conducted by Bajzak et al. (2011) stated that climate change simulations and models have predicted a general decrease of ice duration in the Gulf of St. Lawrence, up to 70 % by 2050, except in the Northumberland Strait. This could potentially lead to more harp seals moving farther south, and into the Northumberland Strait to breed. The population is not listed under any organization as a species at risk, and it has never been assessed by COSEWIC likely due to the abundance of the species.

Cetaceans

The Atlantic white-sided dolphin (*Lagenorhynchus acutus*) is found in the western North Atlantic from North Carolina to Greenland (Hammill et al. 2001), and it is found seasonally in the Northumberland

Strait during the summer months. This species moves closer inshore during the summer months and moving out into deeper southern waters in the winter. Adult dolphins weigh between 180 to 225 kg, and average between 2.5 to 3 m in length. The Atlantic white-sided dolphin is a very social species and will rarely travel alone. There have been recordings of dolphin pods consisting of a few individuals, all the way up to 500 (NOAA 2014a). Breeding season is typically during May to August, and females will give birth to one calf after an 11-month gestation period. The diet of this species consists of a variety of fish, shrimp and squid, and they are often associated with fin and pilot whales while feeding. There are few data collected on population trends, especially in the Gulf of St. Lawrence. In 2007, the best estimated size of the population in the North Atlantic was 63,000 individuals (NOAA 2014a).

The harbour porpoise (*Phocoena phocoena*) is one of the smallest whales in the world and is found in two distinct populations, the Northwest Atlantic and Pacific populations, with the Northwest Atlantic population spread out along the north coast of Labrador down to the Bay of Fundy/Gulf of Maine (DFO 2008). Harbour porpoises are well adapted to cold water and are rarely found in waters warmer than 16 °C. They average approximately 1.6 m in length and 50 kg at full growth, with females tending to be larger than males, and they often travel in small pods of about 10 individuals. Females reach sexual maturity at three years, and will often give birth to a single calf after a 10 to 11-month gestation period. The calf is then nursed for an additional 8 months before being weaned from its mother. The typical diet of the harbour porpoise consists of herring, capelin, cod, hake and sand lance (DFO 2008). Since many of these fish in the porpoise's diet are commercially fished species, bycatch is one of the main threats to the species population. The harbour porpoise is not listed on the *SARA* Schedule 1 list of species at risk; however, it was assessed by COSEWIC in 2006 as a species of special concern, due to the high rate of bycatch from commercial fisheries. While there are populations throughout the Gulf of St. Lawrence, the harbour porpoise is well known to occur in the Northumberland Strait. While the Pacific population of the harbour porpoise is listed under Schedule 1 of *SARA*, the Atlantic population has not been listed; it is currently listed as threatened under Schedule 2.

The fin whale (*Balaenoptera acutorostrata*) is the second largest species of whale in the world, after the blue whale (*Balaenoptera musculus*). It can range in size from 20 to 27 m in length and weigh between 60 and 80 t. Females typically reproduce every two to three years, giving birth to a single calf. There are two main populations of fin whales that are found in Canadian waters, the Pacific and Atlantic populations. The Atlantic population has a wide distribution and can be found in waters as far north as Greenland, down into the Bay of Fundy and the Gulf of Maine (DFO 2013). Fin whales generally do not travel together and will often migrate alone or in very small pods. The fin whale uses baleen to filter food from the ocean water, and its typical diet consists of krill and small fish such as herring and capelin. While there is a general distribution pattern for fin whales throughout the North Atlantic, there is little information regarding their distribution throughout the Gulf of St. Lawrence. During a series of aerial surveys conducted in 1995/1996, fin whales were observed in the Gulf, but none were reported in the southern Gulf region. Observations of fin whales from whale-watching companies between May and October in 2000 indicate that this species will frequently visit the waters of the southern Gulf, including the Northumberland Strait (Hammill et al. 2001). Currently, the fin whale is the only marine mammal known to occur in the Northumberland Strait that has been listed on Schedule 1 of *SARA*. The population is listed as a special concern species.

The long-finned pilot whale (*Globicephala melaena*) has been known to visit the waters of the Northumberland Strait during the summer and fall months, while spending the winter months at lower latitudes such as the Gulf of Maine and the Northeast US coast (Hammill et al. 2001). This is a medium sized species, with males growing up to 8 m and weighing over 2,000 kg. Females typically tend to be smaller, reaching up to 6 m and weighing between 1,000 to 1,500 kg (NOAA 2014b). Females reach sexual maturity at eight years of age, and will give birth to a calf after a 12 to 18-month gestation period. Pilot whales typically prefer deep pelagic temperate to sub-polar ocean waters, but have been known to occur in some coastal bodies. They can dive to depths of around 600 m to find food, which consists of a variety of fish, cephalopods and crustaceans (NOAA 2014b). There are currently two global populations of pilot whales, one in the North Atlantic and one in the southern hemisphere. The North Atlantic population was known to occupy all areas of the Gulf of St. Lawrence; however, the southern Gulf is recognized as its main area of concentration. Pilot whales represent approximately 20 % of strandings off the coast of PEI since 1988 (Hammill et al. 2001). During the construction of the Confederation Bridge, pilot whale observations were recorded during marine environmental effects monitoring programs (JWEL 1994).

3.1.2.2.8 Marine Birds

The Northumberland Strait provides habitat for a wide variety of marine birds that are present both annually and seasonally. During terrestrial environmental effects monitoring during the Confederation Bridge construction, a 1995 survey identified 69 different species of aquatic and marine birds (Table 3.9).

Table 3.9 Summary of Species Identified During 1995 Confederation Bridge Terrestrial Environmental Effects Monitoring Studies

Bird Group (Guild)	Number of Species
Dabbling Ducks	13
Diving Ducks	3
Sea Ducks	13
Sea Birds	9
Diving Birds	9
Shore Birds	18
Waders	2
Geese	2
Total	69
Source: AMEC 2007	

Common inshore seabirds that inhabit the Northumberland Strait include various species of gulls, terns and cormorants. These are birds that spend substantial time at sea in shallow bodies of water, where food is easily accessible, and then they will return to land at night to rest. Offshore seabirds are less common in the Northumberland Strait due to the lack of islands or rocky cliffs, which these birds use as nesting grounds (AMEC 2007). Some examples of offshore birds include auks and petrels.

Waterfowl are generally classified as being of the order Anseriformes (e.g., geese, swans, ducks and mergansers), and marine waterfowl (i.e., seaducks) which are found in the marine environment outside the breeding season. Of the 69 species of marine birds observed during the 1995 terrestrial environmental effects monitoring for the Confederation Bridge project (AMEC 2007), 45 % were ducks and geese and 32 % were seabirds or sea ducks (Table 3.9). Many of these species of waterfowl are migratory and present in the Strait through the spring and fall as they make their transition between breeding and wintering grounds. Spring migration usually spans from March to May, and fall migration lasts from September to November. Some common species of waterfowl that are found in the Strait include all three species of scoter (Black (*Melanitta americana*), White-winged (*Melanitta fusca*) and Surf (*Melanitta perspicillata*)), Long-tailed Duck (*Clangula hyemalis*), Common Eider (*Somateria mollissima*), American Black Duck (*Anas rubripes*), Green-winged Teal (*Anas crecca*), Greater Scaup (*Aythya marila*), Canada Goose (*Branta canadensis*), Red-breasted Merganser (*Mergus serrator*) and Common Goldeneye (*Bucephala clangula*).

The Northumberland Strait ranks second only to the Bay of Fundy in importance as a stopover location for migrating shorebirds. It is estimated that over 30 species of shorebirds will gather in the Strait during the spring and fall migrations (JWEL 2001). The extensive mudflats that are present throughout the Strait provide a crucial food source that the birds need to gather fat reserves and energy for migration to breeding grounds. Migrating shorebirds typically have staging areas that they will return to year after year, which make them more sensitive to disturbance and habitat loss. Common shorebirds that can be found in abundance during the migrating period include Semipalmated Sandpiper (*Calidris pusilla*), Semipalmated Plover (*Charadrius semipalmatus*), Sanderling (*Calidris alba*), Short-billed Dowitcher (*Limnodromus griseus*), Black-bellied Plover (*Pluvialis squatarola*), Least Sandpiper (*Calidris minutilla*), Greater Yellowlegs (*Tringa melanoleuca*), Dunlin (*Calidris alpina*) and Red Knot (*Calidris canutus*) (JWEL 2001).

While the Northumberland Strait typically serves as a stopping point for a large majority of species during their migration period, there are a number of species that are found year-round and breed in the Strait. Areas of the Strait support sensitive nesting areas for certain species. Species that have been known to breed in the Northumberland Strait include terns, plovers, cormorants, Razorbills (*Alca torda*), Willets (*Tringa semipalmata*), Ring-billed Gulls (*Larus delawarensis*), Great Blue Herron (*Ardea herodias*) and Black Guillemot (*Cepphus grylle*).

Terns are small-to medium-sized birds known for their long pointed wings and their quick agile flying, and are found throughout the Gulf of St. Lawrence. There are 17 different types of terns within the tern family, with the Common Tern (*Sterna hirundo*) and Arctic Tern (*Sterna paradisaea*) found in the Northumberland Strait. Terns typically feed on small inshore fish such as sticklebacks, and will feed on small invertebrates as well. Terns are known as diving seabirds, and will often hover above water for a short period of time before diving after their prey (Cornell Lab of Ornithology 2014). Common Terns usually arrive in early May, with Arctic Terns arriving soon after. They will begin to leave the Maritimes in August, and most will be absent by the end of September (JWEL 2001).

Aside from the Piping Plover (*Charadrius melodus,* listed as endangered on Schedule 1 of the *SARA*), the only other plover species that is known to nest within the Northumberland Strait is the Semipalmated Plover. The Semipalmated Plover is a very common migrating shorebird, and is one of the most abundant plover species to be found in the Northumberland Strait. These birds are known to migrate through the Strait during the fall and spring months, and will breed in areas of the Northumberland Strait during the summer. The plover is more tolerant to human activities and disturbances, and anthropogenic structures such as road margins and drill pads have been known as nesting sites (Cornell Lab of Ornithology 2014). These plovers will begin to arrive in late April, with most passing through the Maritime Provinces during migration. However, there are some that will stay to breed and lay eggs in early May. The fall migration begins in mid-July and ends in November, with peak numbers of plover occurring during July to mid-September (JWEL 2001).

The Double-crested Cormorant (*Phalacrocorax auritus*) and the Great Cormorant (*Phalacrocorax carbo*) are the only two known species of cormorants known to visit and breed in the Northumberland Strait. The Double-crested Cormorant is a large matte-black fishing bird with yellow-orange facial skin. They breed in the summer and will migrate south during the fall to spend the winter at lower latitudes. The diet of the Double-crested Cormorant is almost entirely of fish, with only a few crustaceans and amphibians ever being recorded. They are a diving hunter, and will chase fish underwater using its webbed feet (Cornell Lab of Ornithology 2014). The Great Cormorant is the most widely distributed cormorant in the world; however, it is restricted to the east coast in North America, breeding in only a few colonies from Maine to Greenland. Like the Double-crested Cormorant, the Great Cormorant's diet consists of fish, and it will dive and chase its prey underwater. Both species begin to arrive in late March to early April, and begin to lay eggs in late April. Part of the population is non-migratory and will stay at their breeding grounds during the winter. Fall migration usually reaches its peak in October (JWEL 2001).

Razorbills are piscivorous, deep-diving seabirds that are widely distributed through boreal and low-Arctic Atlantic waters. Most Razorbills from North American colonies overwinter south of their breeding range in ice-free, coastal waters, with the largest numbers frequenting shoal areas in the outer Bay of Fundy and Gulf of Maine. The breeding population of razorbills is designated as sensitive under the NBDNR General Status of Wild Species (NBDNR 2014). Nesting for Razorbills typically begins in late May and Early June, with breeding birds remaining in their colonies during the late spring and summer. There are also additional transient birds that will breed outside of the Maritimes and spend the fall and winter at sea.

Willets are large stocky shorebirds with bills that are flat and considerably longer than their head. They are often observed alone, and will walk along beaches and mudflats, deliberately pausing to probe for food. The diet of the Willet typically consists of small insects, spiders, fish, crabs, worms, clams and other marine invertebrates located on the coast (Cornell Lab of Ornithology 2014). Willets have been observed during the late summer and early fall in Bedeque Bay, PEI, which is classified as an Important Bird Area in Canada (Birds Studies Canada and Nature Canada 2015). In 2006, the NBDNR classified the breeding population of Willet as sensitive (NBDNR 2014). Willets first arrive in late April, and those who breed will begin nesting during May. Most Willets will leave the area in August, with the late sightings usually occurring in October.

Ring-billed Gulls are abundant throughout much of North America, including in the Northumberland Strait. They are medium sized birds with a short bill and long wings, and they have an estimated population size of over 1 million (Environment Canada 2009). While this species is considered a marine bird and is common around coastal waters, they are known to live inland, feeding at landfills and living in close association with humans. Ring-billed Gulls usually arrive in the Maritimes in late April and leave between September and November. Most gulls are migratory, but some small numbers will overwinter in areas where mudflats remain open and accessible. The breeding population for Ring-billed Gull is listed as secure by the NBDNR (2014).

Great Blue Heron are the largest of the North American heron species, with a wingspan that can reach 1.8 m. They are present year round on the east coast of Canada and are found in all of the Atlantic provinces except Newfoundland and Labrador. They live in both freshwater and saltwater environments, typically in open coast or marshes where they have a steady source of food. Herons typically eat a variety of organisms within striking distance, including fish, amphibians, reptiles, insect, small mammals and other birds. Herons will generally nest in trees, but will move to ground if there are no trees available (Cornell Lab of Ornithology 2014). They have been recorded nesting on bushes, mangroves and in anthropogenic structures such as duck blinds and channel markers. As of 2006, the NBDNR classified the breeding population of Blue Heron as secure (NBDNR 2014), while the province of PEI holds approximately 33 % of the Great Blue Heron population in the Maritimes (PEIDCLE 2015). Great Blue Herons typically arrive in late March, with breeding beginning in mid-April and young being fledged in August. The fall migration period typically peaks in September and October.

The Black Guillemot is a member of the puffin family that breeds along the coasts of Canada and Greenland and tends to stay year-round in northern waters, foraging near shore. It is a medium-sized bird with a thin bill and large white wing patches across its black body. The Black Guillemot is a surface diving predator, and can last underwater for over two minutes to find prey, which normally consists of fish and crustaceans (Cornell Lab of Ornithology 2014). The Black Guillemot is known to nest on PEI and in New Brunswick, with both the breeding and wintering populations being assessed as secure in 2006 (NBDNR 2014). Black Guillemots arrive at their nesting sites in mid-April, with eggs being laid in early June.

Aside from marine birds that use the Northumberland Strait to breed, the Strait is home to a number of marine birds that are listed under Schedule 1 of *SARA*. These birds are shown in Table 3.10.

Table 3.10 Marine Bird Species Listed on Schedule 1 of the *Species at Risk Act*

Common Name	Scientific Name	SARA Classification
Piping Plover- melodus subspecies*	*Charadrius melodus*	Endangered
Barrow's Goldeneye	*Bucephala islandica*	Special Concern
Harlequin Duck- Eastern Population*	*Histrionicus histrionicus*	Special Concern
Roseate Tern*	*Sterna dougallii*	Endangered
Note: * Protected under the *Migratory Birds Convention Act, 1994.*		

Harlequin duck is a small to medium-sized diving duck which breeds adjacent to fast-flowing streams and winters along rocky marine coastlines. This species feeds primarily upon marine invertebrates, and occasionally on fish, which it catches while diving (Robertson and Goudie 1999). The eastern population of harlequin duck is listed as special concern on Schedule 1 of *SARA*, and as an endangered species under the New Brunswick *SARA*. Two populations of the Harlequin Duck are found in Canada: the western population along the Pacific Coast, and the eastern population along the Atlantic Coast. Harlequin Ducks of the eastern population mostly breed throughout much of Labrador, along eastern Hudson Bay, and the Great Northern Peninsula of the island of Newfoundland. There are known breeding populations along the north shore of the Gulf of St. Lawrence, the Gaspé Peninsula, northern New Brunswick, and southeastern Baffin Island in Nunavut. Small groups may spend the winter along the Gaspé Peninsula and Anticosti Island of Québec, and a few individuals may spend the winter in PEI.

The barrow's goldeneye is a medium-sized diving duck and is listed as *special concern* on Schedule 1 under *SARA*, special concern under the New Brunswick *SARA*, and as *sensitive* under NBDNR General Status of Wild Species. The barrow's goldeneye breeds along lakes in parkland, and winters along rocky coasts (Cornell Lab of Ornithology 2014). In Canada, the eastern population breed in Quebec; however, a small number of this population winter on sheltered shores of the Maritimes. Approximately 400 birds winter in the Atlantic Provinces and Maine (Environment Canada 2013).

The Roseate Tern is a medium-sized seabird that is related to gulls. They are very similar to Common and Arctic Terns and are frequently found in their company. It is distinguished from these two species primarily by its shorter wings, longer tail and paler grey plumage. In North America, two populations of Roseate Tern breed on the Atlantic coast in distinct locations. The northeastern population extends from the Magdalen Islands, in the Gulf of St. Lawrence, south to New York. The Canadian population of Roseate Terns breeds almost exclusively on a few islands off the Atlantic coast of Nova Scotia, although small numbers of birds breed on islands in Quebec and New Brunswick. They feed on small saltwater fish, most frequently Sand Lance, herring, Atlantic Silversides and hake. Roseate Terns nest in colonies almost exclusively on small coastal islands. They breed at sites covered with vegetation dominated by beach grass and herbaceous plants (Government of Canada 2015a).

The Piping Plover is a small, thrush-sized shorebird that blends well into its setting. It is primarily the colour of dry sand, but has distinctive black markings (a black collar or breastband, a black band above the white forehead, and a partially black tail). The short and stout bill is orange with a black tip, and becomes black in winter. The melodus subspecies of the Piping Plover is a North American bird that breeds along the Atlantic coast from Newfoundland to South Carolina. It winters along the Atlantic coast, from South Carolina to Florida, and in the Caribbean (Cuba, Bahamas). In Canada, the melodus subspecies breeds on the Magdalen Islands of Quebec, New Brunswick, Nova Scotia, PEI and Newfoundland. About 25% of Canada's Piping Plovers are found in the Atlantic provinces, and they nest above the normal high-water mark on exposed sandy or gravelly beaches. On the Atlantic coast they often nest in association with small cobble and other small beach debris on ocean beaches, sand spits, or barrier beaches. They also forage for food on these beaches (Government of Canada 2015b).

Piping Plovers arrive on their breeding grounds in Eastern Canada in late April or May. Clutches usually contain four eggs and both parents participate in the incubation of eggs and care of nestlings. Females can begin to breed at one year of age and will re-nest once or twice in a season if the eggs are destroyed. Along with being federally listed as a species at risk, the Piping Plover is listed provincially under the New Brunswick *SARA* (Government of Canada 2015b).

3.1.3 Project Interactions with the Marine Environment

Potential Project interactions with the Marine Environment are presented in Table 3.11. These interactions are indicated by check marks, and are discussed in Section 3.1.4 in the context of effects pathways, standard and project-specific mitigation/enhancement, and residual effects. Following the table, justification is provided for non-interactions (no check marks).

Table 3.11 Potential Project-Environment Interactions and Effects on the Marine Environment

Project Components and Physical Activities	Potential Environmental Effects
	Change in Marine Populations
Construction	
Site preparation for submarine cable	✓
Installation of the submarine cables	✓
Inspection and energizing of the submarine cables	✓
Emissions and wastes	✓
Marine transportation	✓
Operation	
Energy transmission	✓
Infrastructure inspection and maintenance	✓
Emissions and wastes	✓
Decommissioning and Abandonment	
Decommissioning	✓
Emissions and wastes	✓
Transportation	✓

Notes:
✓ = Potential interactions that might cause an effect.
– = Interactions between the project and the VC are not expected.

3.1.3.1.1 Construction

Activities associated with marine construction have potential interactions that might cause an effect with the Marine Environment VC, and are further discussed below in Section 3.1.4.

3.1.3.1.2 Operation

Activities associated with marine operation have potential interactions that might cause an effect with the Marine Environment VC, and are further discussed below in Section 3.1.4.

3.1.3.1.3 Decommissioning and Abandonment

Decommissioning and abandonment will be assessed at the end of the useful life of the Project. The life of the Project is 40 years, at which time it may be decommissioned; however, it is more likely that at that time the Project will be refurbished and will continue to operate on a similar basis in perpetuity. If decommissioning activities are determined to be necessary, it is likely that the cables in the marine environment will be abandoned in place to avoid disturbance of the habitat. Given that the cables are solid dielectric and do not contain oil or other harmful chemicals that could leach into the environment or released if the abandoned cable were damaged, there is no expected interaction with this VC. Any decisions made regarding decommissioning and abandonment will be completed in accordance with the applicable regulations at that time and could include either the abandonment or removal of the submarine cable.

3.1.4 Assessment of Residual Environmental Effects on the Marine Environment

3.1.4.1 Analytical Assessment Techniques

Analytical assessment techniques for the Marine Environment VC rely primarily on Canadian government guidelines, where applicable, and published or peer-reviewed scientific articles to support the environmental effects assessment and thresholds that may be exceeded.

3.1.4.2 Assessment of change in marine populations

3.1.4.2.1 Project Pathways for change in marine populations

Construction

Activities during site preparation and installation of the submarine cables (e.g., excavation in the intertidal zone to prepare the cable landing sites and pre-trenching and trenching of the cable bed) could result in an increased risk of mortality or injury to fish and benthic marine invertebrates in the PDA due to impact from the excavator and the potential increase in TSS from sediment disturbance. Sessile or slow-moving organisms may be buried, smothered, or crushed during the trenching and installation of the submarine cables.

Project vessels may contain water in ballasts that were filled in non-Canadian waters and have the potential to introduce marine invasive species to the Northumberland Strait if improperly discharged.

There is no known literature on bird mortality resulting from collisions with barge or boat-mounted cranes; however, there is extensive literature on avian collisions with various tall structures, such as buildings and communication towers (Erickson et al. 2005). As a result, there is the possibility that marine birds could collide with tall structures, such as cranes and booms, which could be used during Project construction.

Many marine birds are nocturnally active, in part to avoid diurnal avian predators such as gulls. Project structures, such as cranes and vessels, will emit artificial light that can increase predation risk or lead to collisions with structures mounted with lights (Bourne 1979; Montevecchi 2006; Mougeot and Bretagnolle 2000; Wiese et al. 2001). There are multiple other effects that have been observed with respect to interactions between marine construction and marine birds (e.g., circling marine platforms to the point of exhaustion); however, because of the short distance between PEI and New Brunswick, the majority of species are shorebirds/coastal birds.

Installation of the submarine cables is expected to result in temporary disruption of the benthic habitat in the footprint of the PDA. The marine footprint includes two 16.5 km long submarine cables, each with a disturbance area of approximately 10 m in width. The installation of the marine cables will result in the direct disturbance of approximately 33 hectares of seabed (not including the separation area between the two cables).

With the exception of eelgrass beds (Austin et al. 2004), sand substrate offers limited attachment points for macroalgae canopy habitat unless shell fragments or rocks are present (Jones and Stokes 2006). No eelgrass beds were identified along the proposed displacement area of the cable line (see Section 3.1.2 for a description of the baseline nearshore habitat). Disturbance to benthic communities is therefore more likely to be limited to burrowing and sessile fauna. Although there is an initial impact on benthic community composition immediately after dredging, there is no significant ($p < 0.05$) variation in macrobenthic community mean abundance, diversity, number of taxa or species richness between control and dredged sandy sites one day after dredging (Constantino et al. 2009). Overall, the potential for displacement, damage and mortality of large invertebrate fauna by dredging activities depends on their abundance in the dredge trajectory; however the majority (80 to 90%) of displaced mobile species are able to re-burrow very quickly after being displaced (Hauton et al. 2003). The remaining organisms that are unable to re-burrow (due to mortality, injury or biomechanically incapable) are consumed by predators or scavengers along the disturbed area (Hauton et al. 2003). In general, deposit-feeding organisms without external protection (including crustaceans, polychaetes and ophiuroids) are most affected by dredging (Constantino et al. 2009). However, in shallower sandy bottom habitats (<20 m) benthic communities are not highly affected by physical anthropogenic disturbances, likely because these communities are continually subjected to natural disturbance such as surface wave impacts on the benthos (Constantino et al. 2009). Consequently, in deeper water habitats (70 to 80 m) where benthic communities are not accustomed to continual natural disturbances, the effects of displacement of macrobenthic invertebrates is likely to persist for more than a year, as is evident by a reduction in densities of large bivalve burrows in the dredge tract (Gilkinson et al. 2003).

Existing sources of habitat disturbance within the RAA may include commercial fishing activities, specifically scallop dragging. This method of scallop fishing has been associated with direct physical and biological impacts on benthic ecosystems such as reducing habitat complexity and heterogeneity (Currie and Parry 1996), direct benthic infaunal mortality (Boulcott et al. 2013) and mobilization of sediment increasing the release of nutrients and reducing sediment food quality (Watling et al. 2001 and O'Neill et al. 2013). The degree of disturbance depends on several factors such as substrate composition, existing environmental conditions (Kaiser et al. 2006) and the scale and intensity of fishing activity (LeBlanc et al. 2015).

While TSS concentrations can become elevated due to natural processes (e.g., heavy rainfall, storm events), or in certain areas (e.g., nearshore coastal environments), construction activities can increase the concentration of TSS.

There is a wide range of tolerance of fish species to levels of TSS with some species being more sensitive than others (Au et al. 2004). Lower levels of dissolved oxygen are associated with high TSS concentrations (Ntengwe 2006). Elevated TSS concentrations have been associated with high levels of stress in benthic invertebrates (Norton et al. 2002). High concentrations of TSS can also affect fish. Oxygen deprivation has been observed due to sediments coating the respiratory epithelia of fish and cutting off gas exchange with water (Au et al. 2004). Avoidance is the primary response of fish to locally high levels of TSS At high TSS concentrations or prolonged periods of exposure, effects of total suspended sediments on fish have been shown to include: decreased feeding success; reduced ability to detect and avoid predators; gill damage; reduced growth rates; decreased resistance to disease or impaired development of embryos; and may impair reproduction for those species relying on visual cues as a part of courtship and mating(CH2M HILL 2000).

Changes to surficial sediment chemistry could occur as a result of bottom disturbance and re-suspension of existing sediments. Sediment samples collected within the PDA in fall 2014 indicate that the sediment meets the CCME Sediment Quality Guidelines (Marine) and the CEPA Disposal at Sea guidelines. Given these low baseline levels, there is limited risk of marine populations being exposed to acute or chronic toxicity caused by re-suspended sediments; therefore sediment chemistry from sediment disturbance or re-suspension by the Project is not likely a pathway that could result in a change in marine populations.

The cable ship and Project support vessels may operate up to 24 hours a day, 7 days a week during construction. Marine vessel lighting will be required for navigational aids and illumination of work areas during night-time vessel operations. A certain amount of lighting is required for navigational and safety purposes; however, deck lighting will be reduced whenever it is practical to do so and the use of unnecessary lighting will be avoided. If possible, waste lighting will be further reduced through the use of directional overhead lighting focused on work areas, rather than floodlights.

Although operation of Project vessels and equipment will have a deterrent effect on most marine species, there is potential for nocturnally migrating marine birds to be attracted and disoriented by artificial night lighting. Disoriented birds may fly into vessel lights or infrastructure, injuring themselves and becoming stranded.While there are a number of additional effects related to marine bird species with respect to artificial light, there are no known strictly marine bird species in the LAA and the distance between PEI and New Brunswick is not great enough that birds would be attracted to the light source and eventually die of starvation, which has been observed in several species in relation to offshore projects.

Underwater noise introduced during marine construction activities may result in changes in behaviour of fish or marine mammals in the vicinity. Project activities and physical works that may produce underwater noise include trenching, laying of cable, infilling of cable trench, installation of ice scour protection (if necessary), and movement of marine vessels associated with these activities. Excavation of the near-shore trenches will likely require an excavator. Sound levels capable of causing decreased hearing sensitivity or auditory injury (i.e., temporary or permanent noise-induced threshold shifts) are not expected as a result of these construction activities.

The degree to which a marine animal responds to underwater noise depends on a large number of variables including: the nature, magnitude, and duration of the sound, distance from the sound source, species and individual involved, and context (i.e., activity at the time of exposure) (Popper and Hawkins 2012; Richardson et al. 1995; Southall et al. 2007). Marine fish may exhibit a temporary startle response or avoid the source area for the duration of the disturbance (Feist et al. 1996; Hastings and Popper 2005; Thomsen et al. 2012; Wardle et al. 2001). Marine mammals have been known to exhibit a range of responses (Nowacek et al. 2007), from overt avoidance behaviours (Southall et al. 2007) or disruption of foraging patterns (e.g., Sundermeyer et al. 2012; Tougaard et al. 2012), to less obvious responses such as changes to communication (e.g., Castellote 2012; Merchant et al. 2014; Risch et al. 2012; Williams et al. 2013) or increased stress (Rolland et al. 2012).

The potential amount of underwater noise created during trenching is highly variable, and depends on several factors including site-specific details (e.g., type of substrate, level of turbidity) and the type of equipment or installation techniques employed. Noise levels during site preparation and cable installation may exceed behavioural response thresholds for marine mammals within the vicinity of the trenching activity but these are expected to dissipate quickly with distance from the source.

In addition to effects from lighting and noise, there remains the potential for marine wildlife to suffer mortality due to collision with Project vessels or equipment.

Operation

Once installed, the submarine cables will have no further interaction with the marine environment other than their continual presence. Because there will be no direction interaction with marine species associated with the presence of the active cable after it has been installed, interactions are not discussed further in this assessment.

Inspections of the cable will be performed periodically to maintain cable integrity and reliability. The frequency of maintenance requirements will be determined following installation and commissioning. These inspections will identify any areas that require additional protection from scouring. Video inspections are typically performed by a diving contractor. Multi-beam and side-scan sonar surveys may be conducted, as required.

The periodic surveys will check the entire marine cable to confirm that the cable is still buried. A buried cable could accidentally be pulled up out of the seabed (typically related to fishing activities and use of anchors), where it would be vulnerable, even if it is not damaged. The primary environmental effect associated with inspection and maintenance is the vessels used to support divers, remotely operated vehicles, or multi-beam and side-scan sonar surveys, which are likely to generate underwater noise and have the potential to strike marine wildlife.

The production of underwater noise is expected to be minimal during operation of the Project. Occasionally there may be vessels in the area conducting inspection and maintenance activities, although noise is not expected to differ from that of existing fishing and recreational boating in the area.

The transmission of energy through the subsea cables will generate electromagnetic fields (EMF). EMF is a force consisting of direct and induced electric and magnetic components. Some species of marine fish have sensitivities to EMF. The generation of EMF from a subsea cable may interact with certain marine species' ability to navigate and locate prey or predators.

Three EMFs are produced by a subsea cable:

- The direct electric field, which is the primary mode of transmitting electricity along the cable. This field is contained within the subsea cable by insulation and sheathing.
- The magnetic field, which is produced by the transmission of electricity. This field is emitted from the subsea cable and cannot be completely insulated.
- The induced electric field, which is produced by the alternating of the AC magnetic field or from water current flows or marine organisms swimming through the field. This field is emitted from the subsea cable and is entirely outside the cable insulation and sheathing. The magnitude of this force is much lower than the direct electric field contained within the subsea cable.

The subsea cables are designed to shield the marine environment from the direct electric field; the cable sheathing and armouring mitigate the effects of direct electric fields to marine organisms (Gill et al. 2008). Magnetic fields and induced electric fields are created by the transmission of power through the subsea cables. The strengths of these fields are dependent on the distance between the receptor and the source, and the amount of power being transferred through the cables. Research on EMF indicates that fish and marine mammals have sensitivities to both the electric and magnetic components (Fisher et al. 2010). Some species of fish such as skates, rays and sharks (Elasmobranchs) use electric and/or magnetic fields as their primary method of locating food and for migration (Gill et al. 2008). Other marine fish and crustaceans such as salmonids, American eels and spiny lobster use magnetic fields to migrate to and from spawning grounds (Gill et al. 2008; Putman et al. 2013; Walker et al. 2002). The introduction of induced electric and magnetic fields into the Northumberland Strait may interact with navigation and predator/prey detection in marine fish.

Among marine mammals, cetaceans (whales and dolphins) have been the focus of investigations on EMF; no evidence has been presented to indicate pinnipeds are sensitive to electric or magnetic fields (Normandeau et al. 2011). With many cetacean species migrating seasonally up to thousands of kilometers, cetaceans appear to be more sensitive to the magnetic field component of EMF. The current hypothesis is that cetaceans use magnetic fields for long range navigation (Kirschvink 1989; Walker 1992; Hui 1994). Sea turtles, such as the loggerhead turtles, are sensitive to magnetic fields and use magnetic fields for orientation during long range migrations (Lohnmann et al 1997). The introduction of magnetic fields into the Northumberland Strait may interact with cetacean and sea turtle navigation.

When power is transferred through subsea cables, particularly as alternating current, heat is dissipated. In general, XPLE HVAC cable sheath operates at approximately 90°C internally, while it is only warm to the touch on the outside of the cable. The operation of a subsea cable (installed at 0.6 m below the seafloor in water greater than 12 m and 1.6 m below the seafloor in water less than 12 m) may result in localized changes to the benthic infauna, resulting in organisms preferring cold temperatures being replaced by more temperate species.

3.1.4.2.2 Mitigation for change in marine populations

Construction

The following mitigation measures will be applied during Project construction:

- Timing of in-water work will be conducted in consideration of sensitive biological periods (e.g., reproductive life stages), where practical, for CRA species, as determined through discussions with DFO and other regulators.
- Prior to beginning marine works, sediment curtains will be put in place around activities at cable landing sites, if practical, to prevent sediment from entering the water column outside the work area.
- Only clean rock (containing less than 5 % fines and non-acid generating) or native material will be used for infilling (acid generating rock may be used in areas that will be submerged by water at all times).
- Construction vessels will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife.
- Project vessels will comply with applicable legislation, codes and standards of practice for shipping, including the Ballast Water Control and Management Regulations under the *Canada Shipping Act* and the Canadian Ballast Water Management Guidelines, to reduce risk of introduction of marine invasive species.
- Project vessel port of call history and/or records and proof of hull cleaning will be provided prior to entering the Northumberland Strait. Vessel hulls will be cleaned and/or inspected to prior to entering the Northumberland Strait, where necessary.
- Should it be determined that construction activities will result in serious harm to CRA fish or supporting fish species as defined under the *Fisheries Act* and policies a habitat offsetting plan will be prepared for DFO approval and implemented.

- To avoid attracting birds and other wildlife, deck lighting will be reduced whenever it is practical to do so and the use of unnecessary lighting will be avoided.

Operation

The following mitigation measures will be applied during the Project operation:

- The electrical transmission cables will be completely buried to minimizing heat and EMF emissions at the seabed surface.
- Inspection support vessels will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife.

3.1.4.2.3 Residual Project Environmental Effect for Change in Marine Populations

Construction

Residual environmental effects on the Marine Environment VC caused by Project construction are anticipated to result in fish mortality, disruption of habitat with respect to area disturbed, water quality and the acoustic environment. Behavioral changes are expected for marine fish and wildlife.

While there will be residual environmental effects from cable trenching during construction, the effects will be short-term and confined to a relatively small area. The duration of TSS in suspension and the geographic distance over which the sediment is spread depends on several factors: particle size, duration of disturbance, and local oceanographic (current) conditions. The effects of TSS are limited to the four week construction period and will not be focused on one single location. Based on past evidence, this environmental effect will be reversible within a matter of hours to days.

Immediately after dredging, which is analogous to other forms of surface sediment disturbance such as the use of ploughs, a decrease in median grain size of sand between dredged areas and non-disturbed (control) areas has been reported (Constantino et al. 2009). However the median grain size was observed to be similar 17 days after dredging in shallower habitats (< 20 m) (Constantino et al. 2009). In shallower sandy bottom habitats, high-energy wave events appear to mask the effects of dredging perturbation on sediment, especially at shallower depths (6 m); and in general, recovery is faster in shallower areas (Constantino et al. 2009).

In deeper offshore areas, such as 70 to 80 m deep on the Scotia Shelf, the immediate effect of hydraulic dredging in seabed topography is the reduction of low-relief sandy habitat structural complexity such as those attributed to bivalve burrows and polychaete tubes (Gilkinson et al. 2003). However, there is limited understanding of the functional roles of these structures in unconsolidated sediment (Gilkinson et al. 2003). In deeper water habitats, the combined effects of bioturbation by invertebrates and fish, sediment transport by processes such as by storm generated waves and slumping, facilitate considerable erosion of dredge tracts within a year, such that dredge furrows may no longer be visible in video surveys one year after disturbance (Gilkinson et al. 2003). The residual dredge tract may accumulate empty bivalve shells in higher concentrations than the surrounding substrate. However, they provide suitable habitat as attachment sites for colonization by benthic invertebrates which may result in an increase in the abundance and diversity of benthic communities in sandy bottom habitat regions following disturbance by hydraulic dredging (Gilkinson et al. 2003).

The potential for mortality of marine fish and benthos will be confined to the PDA within highly localized areas affected by disturbance of the seabed and adjacent areas of sediment deposition. Harm to fish and mobile invertebrates because of physical disturbance is unlikely, as these species are typically able to avoid burial or crushing. There may be a loss of a limited number of sessile benthic species from benthic habitats during trenching but this would be limited to the PDA. Studies have shown that one year after installation and burial of submarine cables, there is no visual evidence of the physical disturbance to the seafloor (Andrulewicz et al. 2003). In addition, there were no obvious changes in species composition, abundance or biomass of the macrobenthos fauna present in the area. For species that are able to avoid the construction area, the effect will be reversible; for sessile species that are injured during the trenching process the effect will be irreversible.

Harm to fish from short-term elevations of TSS concentrations will be low because of a tolerance of species in the Northumberland Strait due to strong tidal currents, water turbulence and naturally high concentrations of TSS in the coastal areas (refer to Section 3.1.2 Water Quality). There are low opportunities for effects on fish health due to relatively low levels of contaminants in the sediments (see Section 3.1.2 for sediment results). There is no designated critical habitat for marine species in the PDA or LAA for species at risk or species important to CRA fisheries. The mobility of species in the area will make it possible for them to avoid the area during temporary periods of decreased water quality.

To limit any mortality of CRA species or interfering with seasonal migration patterns, the timing of in-water work will be conducted, where practical, in consideration of sensitive biological periods (e.g., reproductive life stages) for CRA species, as determined through discussions with DFO, fishers and other regulators.

Burial of the subsea cables will temporarily disturb the benthic environment. When compared with other activities such as bottom trawling, anchoring or dredging, the effects of cable laying are relatively less intrusive as they occur during a short period of time, are not repetitive in nature, and occur in a relatively smaller footprint area. Sensitive habitats (e.g., eelgrass) may be directly disturbed or lost as a result of cable installation activities; however, no sensitive habitats (e.g., eelgrass beds) were identified during the benthic habitat surveys of the PDA.

If any aspect of the marine construction requires ocean disposal of excavated material, the activity will be conducted in accordance with a Disposal at Sea Permit to be obtained from Environment Canada. The material will meet the *CEPA* Disposal at Sea guidelines and disposal activities will be approved and regulated by Environment Canada. Should it be determined that construction activities will result in serious harm to CRA fish or supporting fish species as defined under the *Fisheries Act* and policies, an Authorization will be sought in accordance with the *Fisheries Act* and a habitat offsetting plan will be prepared for DFO approval.

Marine transportation activities will contribute to underwater noise; however, construction vessels will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife. Behavioural responses are therefore expected to be limited in spatial extent, and are thus unlikely to affect the feeding ability or overall population viability of marine species in the area. Project vessels will comply with applicable legislation, codes and standards of practice for shipping, including the *Ballast Water Control and Management Regulations* under the *Canada Shipping Act* and the Canadian Ballast Water Management Guidelines, to reduce risk of introduction of marine invasive species.

The potential for collisions with marine wildlife will be reduced by the slow speed of the cable ship during Project construction. No high speed maneuvers will be conducted by any Project vessels during cable installation. Therefore, the risk to marine mammals and sea turtles from collision is low.

Marine mammals and sea turtles are generally expected to avoid the area where Project vessels are engaged in cable-laying activities and other Project activities generating underwater noise (e.g., cable trenching, excavation nearshore).

Project personnel will be made aware of the potential presence of marine mammals and sea turtles and informed of the requirement to temporarily halt activities if a marine mammal is observed within the specified safety zones.

Mortality to marine birds, caused by disorientation due to artificial lighting, during construction is expected to be minimal assuming mitigation measures noted above and limited duration of construction activities and spatial extent.

Operation

Maintenance vessels will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife. The vessels will follow *Canada Shipping Act* requirements with respect to discharges into the marine environment.

The transmission of electricity through the subsea cables is anticipated to result in the generation and emission of induced electric and magnetic fields into the marine environment. These fields will be reduced through Project design that includes cable burial and the cable's insulation and sheathing. The strength of the EMF in the marine environment depends on the distance from the source and the amount of power being transferred through the cable. Generally the magnetic and induced electric fields are strongest at the cable surface and decline rapidly with distance (CMACS 2003).

Natural sources of EMF are present in the marine environment and in Northumberland Strait, including the earth's geomagnetic field. The predicted intensity of the natural geomagnetic field in the area of the Northumberland Strait is 50 to 55 μT (Normandeau et al. 2011).

The subsea cables to be installed are high voltage (138 kV) AC cables capable of carrying up to 180 MW each operating with a maximum operating current of 837 A (per phase). Table 3.12 provides values for magnetic and induced fields from similar subsea cables. These values were obtained from a literature review and include calculated values directly over the cable that would represent the highest potential EMF forces. In general, the magnetic field is proportional to the current, meaning if the current passing through the cable increases by three-fold, the magnetic field will increase by three times the original value. The magnetic field is inversely proportional to the distance from the cable, which implies that if the magnetic field of 8 μT is measured at 0.5 m, then at a distance of 1.0 m the theoretical magnetic field would be 4 μT. The sediment type and cable burial depth does not alter the attenuation of the magnetic field; the burial depth of the cable only serves to increase the distance between the cable and the seafloor.

Table 3.12 EMF Emissions from Typical HVAC Subsea Cables

Voltage	Current	Distance above Seabed	Depth of Cable Burial	Magnetic Field	Induced Electric Field	Citation
145kV	100 A	0 m	0.5 m	7.1 μT	-	Olsson et al. 2013[1]
145kV	300 A	0 m	0.5 m	21 μT	-	Olsson et al. 2013[1]
145kV	500 A	0 m	0.5 m	35 μT	-	Olsson et al. 2013[1]
132kV	350 A	0 m	1.0 m	1.6 μT	91.25 μV /m	Olsson et al. 2013[2]
132kV	350 A	7 m	1.0 m	0.7 μT	10 μV /m	Olsson et al. 2013[2]
138kV	100 A	0 m	0.5 m	9.85 μT	-	Normandeau et al. 2011[1]
138kV	100 A	0 m	1.0 m	2.45 μT	-	Normandeau et al. 2011[1]
138kV	100 A	0 m	2.0 m	0.61 μT	-	Normandeau et al. 2011[1]
138kV	536 A	1 m	2.4 m	1.01 μT	-	Tetra Tech 2012[1]
138kV	536 A	1 m	4.6 m	0.46 μT	-	Tetra Tech 2012[1]

Notes:
1 Theoretical calculated values.
2 *In-situ* measured values.

The potential effects of EMF is focused on species which are known to rely on electric or magnetic fields for migration or predator/prey detection and are either a Species of Conservation Concern (SOCC) or a CRA fishery species.

The EMF assessment focusses on benthic fish, crustaceans, and skates as they interact with the benthic marine habitat and are more likely to be in close proximity to electrical and magnetic fields. Marine mammals, sea turtles and pelagic fish species are not included in the assessment as the attenuation of EMF results in values approximating background at distances greater than 15 m.

The species identified to potentially interact with project related EMF include:

- Atlantic cod – Commercial Species and SOCC
- Atlantic lobster - Commercial Species
- rock crab - Commercial Species
- smooth skate (*Malacoraja senta*) (Laurentian-Scotian population) - SOCC
- thorny skate (*Amblyraja radiate*) - SOCC

A literature review was conducted for each species above to determine if an electric or magnetic sensitivity was the primary pathway for potential effects. It was determined that Atlantic lobster and rock crab would be most sensitive to magnetic fields. Atlantic cod, smooth skate and thorny skate individuals would be most sensitive to electric fields, though are now thought to be sensitive to magnetic fields, as well (Normandeau et al. 2011).

The sensitivity to magnetic fields has been examined for a few species of marine crustaceans (Normandeau et al. 2011), most notably spiny lobster (*Panulirus argus*). It was determined through laboratory and field studies that the geomagnetic field can be sensed by spiny lobster, and lobster use this magnetic field for migration and homing (Boles and Lohmann 2005; Cain et al 2005; and Lohmann et al. 2007). Theoretical calculations suggest that magnetic fields would need to be 5 μT to be detectable by spiny lobster. This is likely to only occur within metres of a HVAC subsea cable (Normandeau et al. 2011). The US Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is currently conducting research into the effects of EMF on adult Atlantic lobster. The results indicate that there were no statistical changes in behavior or localized movement of Atlantic lobster in a tank with magnetic fields between 500 μT and 1,100 μT as compared to a reference tank.

BOEMRE is also researching the effects of magnetic fields from an existing 35 kV AC subsea cable on macroroinvertebrates. Research indicates that magnetic fields on the cable skin were 109 to 112 μT and decreased to 0.2 to 0.3 μT at 1 m (PNNL 2013). The research suggests no response (attraction/repulsion) from crabs to the EMF emitted by the subsea cable (BOEM 2015). An additional experiment off the coast of British Columbia used Dungeness crabs to determine if the crabs would cross a power cable to enter a baited trap. The results suggest that crabs will cross unburied 35 kV AC subsea cables to enter baited commercial traps (BOEM 2015).

Using the modelled data from Normandeau et al. (2011), a 138kV cable buried 1 m below the seafloor and operating at the maximum theoretical current of 837 A (per phase) has a predicted magnetic field of approximately 31 μT at the seafloor and decreases to 5 μT at a distance of 6 m above the seafloor and to 2 μT at 15 m. Effects of magnetic fields on CRA and SOCC species specific to the Project are not yet well understood and Project-specific magnetic field thresholds have not been developed. Publications are available which identify potential biological effects (Normandeau et al. 2011); however, these effects are limited to localized attraction or repulsion and not necessarily related to fish health. The scale at which various physiological effects may occur is thought to extend approximately 15 m in all directions from the cables. With the 200 m separation between the cables no additive effects between cables are expected. This limited spatial extent of magnetic fields associated with the 138 kV HVAC cables and the mitigation planned by Project design (burial, cable sheathing and armouring), the residual adverse environmental effects of magnetic fields on CRA and SOCC species and changes to their population is expected to be not significant.

Direct electric fields are produced within the cable during the transmission of electricity. These direct electric fields are completely mitigated by cable design and insulation. Induced electric fields can be produced in the marine environment by alternating of AC magnetic fields or from water current flows or marine organisms swimming through the field. Very little literature is available on the level of induced electric fields from the operation of subsea HVAC cables. Ongoing studies in the North Sea around wind farm developments indicate that the induced electric fields may result in attraction or repulsion (EPRI 2013).

Fish abundances around a 132 kV AC cable in the North Sea were monitored two years following the initiation of power transmission. The distribution of Atlantic cod was determined to be significantly different during power transmission (Dong and Vattenhall 2006). In that study the Atlantic cod appeared to gather in the area immediately adjacent to the cable in greater numbers. The authors were cautious about the interpretation as the seafloor was not completely restored to baseline conditions and may have resulted in influencing fish behavior (Normandeau et al. 2011.

There is select literature on electric fields interacting specifically with thorny or smooth skates. Raschi and Adams (1988) theorized that the size and distribution of pores on the skin of thorny skates would promote sensitivity to electric fields, though this theory was not tested and a threshold was not determined. Smooth skates and thorny skates are grouped in the same family (thornbacks). Literature is available for skates of the same family indicating that physiological responses are present when electric fields are as low as 100 µV /m (Kalmijn 1971). The sensitivity of electric fields in skates is dependent on the frequency of the electric field; skates are most sensitive to electric fields between 1 to 10 Hz and less sensitive outside this frequency from 0.01 to 25 Hz (New and Tricas 1997; Bodznick et al. 2003). Experimental observations were observed from a COWRIE 2.0 EMF study (Gill et al. 2005). This study indicated that the movement of thornback rays increased when the cable was powered compared to an unpowered cable. The responses indicated a behavioral effect on thornback rays from the operation of a 135kV subsea cable with an operating induced electric field of 36 µV /m.

Considering the lack of demonstrated adverse effects and the limited spatial extent of induced electric fields associated with 138 kV HVAC cables and the mitigation planned by Project design (burial, cable sheathing and armouring), the residual adverse environmental effects of induced electric fields on CRA and SOCC species and changes to their population is expected to be not significant.

3.1.4.3 Summary of Residual Project Environmental Effects

The residual Project environmental effects for the Marine Environment are summarized in Table 3.13.

Table 3.13 Summary of Project Residual Environmental Effects on the Marine Environment

Residual Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Marine Populations	C	A	L	PDA	ST	MR	R/I	D
Change in Marine Populations	O	N	L	PDA	LT	C	R	D

KEY
See 3.2 for detailed definitions.
Project Phase:
C: Construction
O: Operation
D: Decommissioning and Abandonment
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
RAA: Regional Assessment Area
Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term

NA: Not applicable

Frequency:
S: occurs only once
MIR: Multiple irregular event
MR: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

3.1.5 Determination of Significance

3.1.5.1 Significance of Residual Project Effects

The marine construction phase of the Project will result in temporary, localized disturbance to the benthic habitat in the PDA. Increased ambient sound levels from construction activities may result in minor habitat avoidance during the construction period in the PDA. During operation any potential effects from EMF emissions will be confined to the PDA and are expected to be minor.

In summary, any residual adverse environmental effects related to a change in marine populations during all phases of the Project, are rated not significant.

3.1.6 Prediction Confidence

Prediction confidence is generally considered to be high due to the knowledge related environmental effects associated with marine construction projects such as the installation of submarine cables. Aspects of the effects prediction are considered moderate because studies have produced inconclusive results of adverse environmental effects from electric, magnetic or heat emissions generated by power cables in the marine environment. During operation, however, Project effects on marine species and populations are predicted to be limited to localized avoidance, if any, as a result of electric and magnetic emissions and physical disturbance.

3.1.7 Follow-up and Monitoring

There are no suggested follow-up and monitoring activities for the marine environment.

3.2 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON COMMERCIAL, RECREATIONAL AND ABORIGINAL FISHERIES

Commercial, Recreational and Aboriginal (CRA) Fisheries are important to the local and regional economy, traditions and cultural heritage of the region. These fisheries have been included as a VC due to the regulatory requirements of the *Fisheries Act* and the potential for Project components to interact with CRA fisheries during construction and operation activities. This VC addresses potential Project effects on CRA fisheries, including Aboriginal communal commercial fisheries.

Project activities and components could affect targeted CRA fishery species; therefore this VC is correlated with the assessment of the Marine Environment VC (Section 3.1) including potential biological effects on marine commercial species. Due to the nature of existing and historical Aboriginal fishing activities within the region, the CRA Fisheries VC is closely related with the VC for Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons (i.e., for food, social, and ceremonial purposes), which is addressed in Section 3.4.

3.2.1 Scope of Assessment

3.2.1.1 Regulatory and Policy Setting

CRA fisheries in the Northumberland Strait are guided under the federal *Fisheries Act*. Provisions under the *Fisheries Act* protect fish and fish habitat, including fisheries resources, and apply specific regulations governing CRA fisheries. Section 35 of the *Fisheries Act* restricts work, undertakings or activities that result in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery. Section 36 of the *Fisheries Act* prohibits the release or deposit of deleterious substances in water frequented by fish or in any water where fishing is conducted. CRA fishing activities in the Northumberland Strait fall within the jurisdiction of four sets of regulations under the *Fisheries Act*: *Maritime Provinces Fishery Regulations*; *Atlantic Fishery Regulations*; *Aboriginal Communal Fishing License Requirements*; and *Fishery (general) Regulations*. The mandate of each set of regulations is outlined below.

- The *Maritime Provinces Fishery Regulations* govern fishing activity in inland and adjacent tidal waters of the provinces of New Brunswick, PEI and Nova Scotia.
- The *Atlantic Fishery Regulations* provide for the management and allocation of fishery resources off the Atlantic coast of Canada.

- *Aboriginal Communal Fishing License Requirements* provide for the management and allocation of Aboriginal fishery resources within Canada.
- *Fishery (general) Regulations* provide for the management of fishing activity within Canada that fall outside of the regulations described above including recreational fishing activities under the jurisdiction of DFO and that are beyond the scope of provincial fishery regulations.

Fishery resources are protected from uncontrolled fishing activity through various measures such as area closures, fishing quotas, fishing seasons, and gear and vessel restrictions as described and detailed under the regulations presented above and by Fisheries Management Decisions applied by DFO in accordance with the roles and responsibilities outlined in the *Fisheries Act* (DFO 2013a). Other broad mechanisms for the protection of marine resources are provided in the federal *Oceans Act* which governs the establishment and alteration of fishing zones and Marine Protected Areas within Canadian waters.

Provincial administration of aquaculture falls under the jurisdiction of regulations in both New Brunswick and PEI. In New Brunswick, the Department of Agriculture, Aquaculture and Fisheries and the Department of Natural Resources implement the *Fisheries and Aquaculture Development Act* and the *Fish and Wildlife Act*. In PEI, the Department of Agriculture and Fisheries and the Department of Communities, Land and Environment implement the *Fisheries Act*.

3.2.1.2 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date applicable to the CRA Fisheries VC include the potential effects of Project activities and components and accidental events on fish and fish habitat and commercial fishing activities (e.g., loss of access). Questions have been raised regarding the construction and installation methods, materials and scheduling. Other questions pertain to post construction operational conditions such as any restrictions on fishing gear or loss of fishing grounds (e.g., fishing exclusion zones). Other issues raised pertain to electromagnetic fields (EMF) generated during the operational phase of the Project and the potential environmental effects of EMF on species abundance, distribution and migration. Interaction between EMF and the marine environment is discussed in Section 3.1, Marine Environment VC.

Key issues raised during stakeholder engagement are addressed in Section 3.2.4, Assessment of Residual Environmental Effects on CRA Fisheries.

3.2.1.3 Potential Environmental Effects, Pathways and Measurable Parameters

CRA fisheries are important to both the local and regional New Brunswick and PEI economies. CRA fishing activities are an important traditional and cultural activity within the Northumberland Strait and the Project could have an effect on local CRA fisheries. Potential environmental effects, effects pathways and measurable parameters for the assessment of CRA Fisheries are presented in this section.

Construction of the submarine cable, including installation methods and ground disturbance activities and biological effects on CRA species are primarily described in the Marine Environment VC (Section 3.1) and will not be repeated in this VC.

The marine construction phase of the Project has been provisionally scheduled to commence with pre-trenching of inshore areas in spring 2016 with the remaining trenching and cable installation to take place in fall 2016 after the fall lobster fishery. Contractor construction methods or unforeseen circumstances (e.g., adverse weather or equipment malfunction) may require alteration of construction schedules and may result in localized interference with CRA fishing activities.

During Project operation, routine maintenance and inspection activities on the submarine cables will, when feasible, be scheduled during commercial fishing off seasons. In the event of emergency situations, inspection and maintenance activities may be required on short notice and may overlap with commercial fishing seasons.

Decommissioning and abandonment would take place following the useful service life of the Project and would be carried out in accordance with regulations in place at that time.

In consideration of the Project components and pathways described above, the assessment of Project-related environmental effects on CRA Fisheries is focused on the following potential environmental effect:

- Change in commercial or Aboriginal commercial fishing activities

The measureable parameter used for the assessment of this environmental effect is localized commercial fishing effort. This parameter is an indicator of change that may result from a reduction in the local commercial fishing effort in the vicinity of the Project footprint due to access restrictions and may be used to compare past and present conditions. The potential environmental effects, effects pathways and measurable parameters for CRA Fisheries are summarized in Table 3.14.

Table 3.14 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Commercial, Recreational and Aboriginal Fisheries

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Commercial or Aboriginal Commercial Fishing Activities	• Loss of access to fishing grounds.	• Localized commercial fishing effort.

Aboriginal fishing activities discussed in this VC are included in commercial fishing activities; food, social and ceremonial (FSC) fisheries are addressed in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons VC, Section 3.4.

Potential environmental effects on CRA species due to habitat loss or displacement is primarily discussed in Section 3.1, the Marine Environment VC.

Potential effects on local recreational fishing activities are considered to be negligible; they are primarily addressed in Section 3.2.2.

Environmental effects on the aquaculture industry are not anticipated due to distance from the Project footprint. The nearest aquaculture sites in New Brunswick are in Spence Settlement (New Brunswick Agriculture, Aquaculture and Fisheries, n.d.) approximately 7 km west of submarine cable landfall on the New Brunswick shoreline. The nearest aquaculture sites in PEI are located in Cape Traverse (DFO 2013b), approximately 3 km east of cable landfall on the PEI shoreline. Local vessel traffic to the aquaculture sites will continue to have access to local wharves or other required shoreline infrastructure throughout the duration of the Project.

3.2.1.4 Boundaries

The spatial and temporal boundaries for the assessment of the CRA VC are described in this section.

3.2.1.4.1 Spatial Boundaries

The Project Area is located within the Northwest Atlantic Fisheries Organization (NAFO) Unit Area 4T which encompasses the entire Southern Gulf of St. Lawrence region. These boundaries include the following DFO regulated fishing zones:

- Lobster Fishing Area (LFA) 25
- Scallop Fishing Area (SFA) 22
- Rock Crab Fishing Area (LFA) 25
- Herring Fishing Area (HFA) 16E
- Groundfish Fishing Area (GFA) 4T7
- Mackerel Fishing Area (MFA) 16

The spatial boundaries for the environmental effects assessment of CRA Fisheries are shown in Figure 3.10 and defined below.

- Project Development Area (PDA): The PDA is a 220 m wide corridor extending approximately 16.5 km between Borden-Carleton and Cape Tormentine. This includes the 10 m wide disturbance area for each submarine cable and the 200 m separation distance between the two cable trenches. The actual area of physical disturbance during construction is approximately 33 ha.
- Local Assessment Area (LAA): The LAA includes the PDA area and extends 1 km on either side of the PDA; the LAA is the maximum area where Project-specific environmental effects can be predicted and measured with a reasonable degree of accuracy and confidence.
- Regional Assessment Area (RAA): The RAA includes the marine waters within the administrative boundaries of LFA 25. The RAA was defined as LFA 25 because all Project activities fall within this commercial fishing administrative boundary. SFA 22 and GFA 4T7 maintain the same geographical boundaries as LFA 25. Included within the RAA are sections of the commercial fishing administrative boundaries of HFA 16E and MFA 16.

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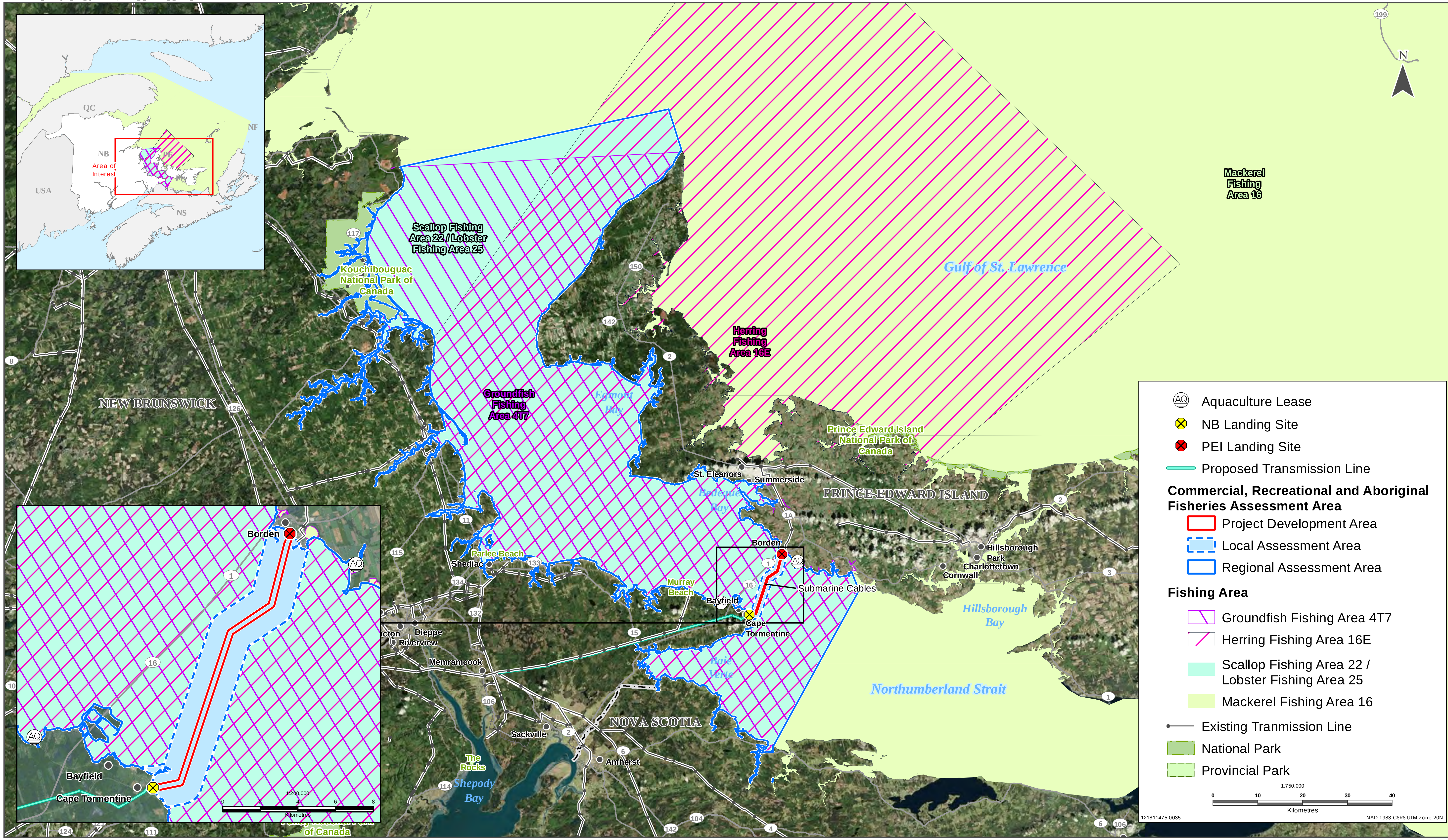


Sources: GeoNB, NB Power, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Stantec

121811475 - PEI - NB Marine Cable Interconnection - Maritime Electric Company Limited

Commercial, Recreational and Aboriginal Fisheries Assessment Boundaries

Figure 3.10

3.2.1.4.2 Temporal Boundaries

The temporal boundaries of the Project for the assessment of potential environmental effects on CRA Fisheries include the anticipated period of construction, operation, and decommissioning and abandonment components.

Total construction time in the marine environment will take place over a 20 to 25 week period. Pre-trenching in water less than 12 m is scheduled to take place between May and early July 2016. Timing of the pre-trenching work will be conducted to avoid, where feasible, the commercial rock crab and lobster fishing seasons in Zone 25. The remaining trenching and cable installation are scheduled to be installed in October and November 2016 after the fall lobster fishery. Operation will begin following construction in December 2016 and is anticipated to continue for the life of the Project (approximately 40 years). Decommissioning and abandonment would take place following the useful service life of the Project and would be carried out in accordance with regulations in place at that time.

The timing windows for in-water construction has been planned for May through early July in waters less than 12 m to avoid working in the scallop fishing area during scallop fishing season as well as to avoid the lobster migration period within the RAA, if feasible. Construction will resume in October after the lobster fishing season is complete.

3.2.1.5 Residual Environmental Effects Description Criteria

Table 3.15 provides the environmental effects classification criteria that are used to characterize and describe Project residual environmental effects on CRA Fisheries.

Table 3.15 Characterization of Residual Environmental Effects on Commercial, Recreational and Aboriginal Fisheries

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 commercial fisheries relative to baseline. **Adverse**—an effect that moves measurable parameters in a direction detrimental to commercial fisheries relative to baseline. **Neutral**—no net change in measureable parameters for the commercial fisheries relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions.	**Negligible**—no measurable change to commercial fisheries. **Low**—a temporary loss of fishable ground to either the New Brunswick or PEI fishers adding up to less than or equal to one quarter of the PDA. **Moderate**—a temporary loss of fishable ground to either the New Brunswick or PEI fishers adding up to approximately one half of the PDA. **High**—a temporary loss of fishable ground to either the New Brunswick or PEI fishers across the entire PDA.

Table 3.15 Characterization of Residual Environmental Effects on Commercial, Recreational and Aboriginal Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Geographic Extent	The geographic area in which an environmental, effect occurs.	**PDA**—residual effects are restricted to the PDA. **LAA**—residual effects extend into the LAA. **RAA**—residual effects interact with those of other projects in the RAA.
Frequency	Identifies when 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.
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived.	**Short-term**—residual effect restricted to less than one fishing season. **Medium-term**—residual effect extends through approximately one fishing season. **Long-term**—residual effect extends beyond one fishing season but is not permanent. **Permanent**—effects are permanent.
Reversibility	Pertains to 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 after activity completion and reclamation. **Irreversible**—the effect is unlikely to be reversed.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur.	**Undisturbed**—Commercial or Aboriginal commercial fisheries are relatively undisturbed due to limited vessel traffic, development and other anthropogenic activities in the area. **Disturbed**—Commercial or Aboriginal commercial fisheries are often disturbed due to interactions with heavy vessel traffic, development or other anthropogenic activities in the area.

3.2.1.6 Significance Definition

For the purposes of this effects assessment, a significant adverse residual environmental effect on commercial fisheries is defined as a residual Project-related environmental effect that results in the following outcome:

- Local commercial or Aboriginal commercial fishers are displaced or unable to access substantial portions of the fishing areas currently used for all or most of a particular fishing season.

3.2.2 Existing Conditions for Commercial, Recreational and Aboriginal Fisheries

3.2.2.1 Methods

Information regarding current CRA fishing activities in the Northumberland Strait was obtained through review of existing literature, online public resources, engagement with stakeholders and formal data requests from DFO Gulf Region.

3.2.2.2 Overview

3.2.2.2.1 Commercial Fishing

Commercial fisheries in the Northumberland Strait are an important source of employment for coastal communities in New Brunswick and PEI and are important to the local and regional economies of New Brunswick and PEI. Fisheries are managed by DFO through regulations under the *Fisheries Act,* and DFO sets the catch or quota limits, fishing seasons and gear restrictions in consultation with industry stakeholders for the targeted species. The federal regulations have been implemented to promote the longevity of the industry and healthy fish populations, and are subject to change based on new data, research and environmental conditions. Fishery specific landing data is gathered by DFO and this data is available through online resources and data requests.

There are four main commercial fisheries within the Project RAA; American lobster, deep-sea scallop, rock crab and Atlantic herring. Groundfish and Atlantic mackerel fisheries are present within the RAA but minimal effort is directed toward these fisheries (Mallet P pers. comm., 2015). Most of the groundfish fishery effort occurs outside of the RAA and targets five species; winter flounder, witch flounder, American plaice , Atlantic halibut and redfish (*Sebastes mentella*) (Lavoie C, pers. comm., 2015). Due to the limited fishing effort within the RAA and the small size of the PDA, the groundfish fishery and mackerel fishery will not be considered a significant fishery within this VC. Due to the limited seasons for most of the fisheries within the RAA, it is common for individual fishers to hold a license for more than one fishery.

Within a given year, effects on CRA Fisheries are most likely to occur within the regulated fishing seasons. Table 3.16 lists the current commercial fisheries and regulated seasons.

Table 3.16 Regulated Seasons for Commercial Fisheries in the RAA

Species	Area Location	Season
Lobster	LFA 25	Typically mid-August to mid-October (subject to change each year).
Scallop	SFA 22	Typically mid-May to mid-June, 6:00 am to 6:00 pm closed on Sundays (30 days).
Rock Crab	LFA 25	Summer (e.g., June 29 to July 25, 2015). Fall: Five calendar days after closure of lobster season to the last Friday in November (e.g., Nov. 27, 2015).
Herring	HFA 16E	Spring (e.g., April 22 – April 29 or June 30, 2015) and gear dependent. Fall: typically late-August to early September.

Table 3.16 Regulated Seasons for Commercial Fisheries in the RAA

Species	Area Location	Season
Groundfish	GFA 4T7	Typically April to December (e.g., April 1 to December 31, 2015).
Mackerel	MFA 16	Typically June to December (e.g., June 1 to December 31, 2015).

Lobster is the principal fishery within the RAA with 711 licenses currently operating within LFA 25. Each license is limited to 250 traps on the New Brunswick shore and 240 traps on the PEI shore. Only lobster that have a carapace length greater than 71 millimeters (mm) may be retained and females with a carapace length of greater than or equal to 114 mm must be released. The fishery is well regulated and managed due in part by limited fishing seasons and the trap design which allows small individuals to escape and reduces the capture of non-target species (DFO Science 2013a). Lobster landings within the RAA as reported by DFO (Lavoie C, pers. comm., 2015) for 2014 were 5,913,437 kilograms (kg).

The number of authorized lobster licences has gradually decreased over the past ten years from a high of 855 in 2005 to a low of 711 in 2014. The number of active licences has also decreased from a high of 791 in 2005 to a low of 651 in 2013. Lobster landings have seen a reverse trend with reported landings gradually increasing from a low of 2,477,554 kg in 2005 to a high of 5,913,437 kg in 2014.

The rock crab fishery is made up of three components; the bycatch fishery, the bait fishery and the directed fishery. The bycatch and bait fisheries are conducted during lobster season by lobster license holders who are permitted to keep an unlimited number of male rock crabs of any size for either bait for the lobster fishery or to sell; female rock crabs must be released. Rock crab bycatch in the lobster industry has been declining since 2006 and is estimated to be less than 10% of the directed fishery landings (DFO Science 2013b). The directed rock crab fishery maintains the same geographical boundaries as LFA 25 and is regulated by the number of licenses issued, trap allocation, gear restrictions, limited seasons and specific catch criteria. License holders are restricted to a total catch allocation of 25,000 kg per season and 100 traps per license. Directed fishing efforts are widely distributed in coastal waters less than 35 m water depth with 239 licenses issued within LFA 25. Rock crab landings within the RAA as reported by DFO (Lavoie C, pers. comm., 2015) for 2014 were 1,131,464 kg.

Directed rock crab licences have remained relatively unchanged over the past ten years varying from 70 to 71 issued licences. The number of licences with reported landings across all three rock crab fisheries (bycatch, bait and directed fisheries) decreased from a high of 396 in 2005 to a low of 109 in 2014. Reported rock crab landings remained relatively stable from 2005 to 2013 ranging from 1,416,831 kg to 1,792,356 kg over this period but decreased to 1,131,464 kg in 2014.

Scallop fishing is considered a secondary fishery within the RAA with 200 licenses issued for SFA 22; approximately 50% of the licenses are currently active. Low scallop density is believed to be an important factor in the low participation of the scallop fishing industry in the Northumberland Strait (DFO Science 2011). Regulations specific to each SFA have been implemented to manage the fishery and include designated scallop fishing areas, scallop fishery buffer zones, restricted fishing seasons and ring size dimension on the scallop dredge. Scallop fishery buffer zones were implemented to protect lobster larval settling areas and were set jointly by DFO and industry. In SFA 22 all habitat in less than 11 m water depth is prohibited to scallop fishing activities. At the request of harvesters in 2005 a large area west of the Confederation Bridge was closed to scallop fishing to allow the stock to rebuild. With these restrictions currently in place, much of SFA 22 is closed to scallop fishing activities. Scallop landings within the RAA as reported by DFO (Lavoie C, pers. comm., 2015) for 2014 were 70,136 kg.

The number of authorized scallop licences has remained relatively unchanged over the past ten years varying from 200 to 203 issued licences. The number of active licences has also remained relatively unchanged over this same period varying from 96 to 110 in any given year. Reported landings have fluctuated over the past ten years with no general increasing or decreasing trends emerging. The lowest reported landings of 52,978 kg occurred in 2006 and the highest of 87,916 kg occurred in 2011.

The herring fishery is divided into seven HFAs within NAFO Unit Area 4T and the RAA falls within HFA16E. For reporting and regulation purposes, DFO manages HFA 16E combined with HFA 16C (Lavoie C, pers. comm., 2015). Herring are fished using two methods; fixed gear (gillnets) and mobile gear (seines). The gillnet fleet operates in the nearshore shallow water areas of the HFAs and the seiner fleet operates in deeper water offshore. The herring fishery within HFA 16E and C is divided into the spring and fall spawner fisheries and is managed using a total allowable catch (TAC) limit imposed on the entire fleet. Total allowable catch is divided between the two fleets with 77% being allocated to the gillnet fleet and 23% allocated to the seiner fleet. A total of 1,022 herring licenses have been issued within HFAs 16 E and C and landings data as reported by DFO (Lavoie C, pers. comm., 2015) for 2014 were: 260 tonnes (t) for New Brunswick and 160 t for PEI giving a total of 420 t representing 92.5% of the TAC set at 454 t.

For the mackerel fishery, the MFA for the region maintains the same geographical boundaries as NAFO Unit Area 4T and is labeled as MFA 16. Atlantic mackerel is fished using several different methods such as gillnets, drift nets, traps and seines. The fishery is divided into two fleets; the inshore fleet (vessels less than 65 feet in length) and the offshore fleet (vessels greater than 65 feet in length). A Canada-wide TAC of 8,000 t has been issued and is divided between the two fleets where 60% has been allocated to the inshore fleet and 40% has been allocated to the offshore fleet. A total of 3015 licenses have been issued for MFA 16 with landings data as reported by DFO (Lavoie C, pers. comm., 2015) for 2014 was 1,016 t from a quota of 8,000 t.

3.2.2.2.2 Recreational Fishing

Recreational fishing in the Northumberland Strait is a social, leisure or sport activity. Recreational fishing activities within the RAA are likely limited to shellfish harvesting, striped bass sport fishing, mackerel fishing and groundfish fishing. Each fishery is managed under specific regulations outlined by DFO and is subject to change based on new data, research and environmental conditions.

Shellfish harvesting is a popular activity throughout the Northumberland Strait and is an easily accessible fishery to the general public. This recreational fishery is monitored by the Canadian Shellfish Sanitation Program (CSSP) which is a federal food safety program jointly directed by the Canadian Food Inspection Agency (CFIA), Environment Canada (EC) and DFO. The goal of the program is to protect Canadians from the health risks associated with the consumption of contaminated bivalve molluscan shellfish (CFIA 2015). Regular water quality testing is carried out by the CSSP to determine levels of biotoxins, bacteria and harmful contaminants in the waters around popular shellfish harvesting areas. If these levels exceed safe limits DFO will issue closure orders and all shellfish harvesting from these areas is prohibited until the closure is lifted (CFIA 2015). Shellfish harvesting is done by hand with small tools such as forks, rakes or spades in intertidal areas where sand bars or flats become accessible at low tide. DFO has set regulations on the number and size of bivalves that are able to be kept during recreational harvesting. In New Brunswick and PEI a person is limited to 300 bivalves in aggregate of the following species per day; bar clam (*Spisula solidissima*), bay quahog (*Mercenaria mercenaria*), razor clam (*Ensis arcuatus*) and soft-shell clam (*Mya arenaria*). In New Brunswick harvested bay quahog, bar clam and soft-shell clam must be greater than 38 mm, 76 mm and 38 mm in length, respectively, and in PEI harvested bay quahog, bar clam and soft-shell clam must be greater than 50 mm, 76 mm and 50 mm in length, respectively (Justice Laws 2015b). The Project will likely have a negligible effect on this recreational fishery due to the small PDA and short construction timeframe.

Recreational mackerel fishing is a popular activity within the Northumberland Strait during the summer migration. Public wharves are common locations for recreational mackerel fishing and several private fishing charters offer fishing excursions from both New Brunswick and PEI. The Project will likely have a negligible effect on this recreational fishery due to the small PDA, short construction timeframe and public wharves remaining accessible during construction, operation, and decommissioning and abandonment.

A recreational striped bass (*Morone saxtalis*) sport fishery has recently been opened by DFO in the Southern Gulf of St. Lawrence. DFO manages the fishery by using limited seasons, bag and size limits, and catch and release policies. In 2015 this fishery is open from May 1 to October 31 with retention periods from May 11 to 31, from August 1 to 23, from September 4 to 7 and from October 24 to 31. All other dates are catch and release only. Anglers are permitted to retain and possess one striped bass per day with legal size of a total length greater than 50 centimeters (cm) and less than 65 cm (DFO 2015a). Due to the limited amount of preferred striped bass habitat within the LAA it is unlikely that recreational fishing for striped bass occurs in the LAA and therefore the Project will likely have a negligible effect on this recreational fishery.

Recreational groundfish fishing in the Southern Gulf of St. Lawrence is managed by DFO. The season is open from April 15 to October 4 in waters within 50 m of the coastline adjacent to New Brunswick and PEI (DFO 2015b). Anglers are permitted to retain a total of 15 groundfish with the exception of the following which cannot be retained: Atlantic cod, white hake, skate (all species), haddock (*Melanogrammus aeglefinus*), Pollock (*Pollachius pollachius*), Atlantic halibut, and wolfish (northern and spotted). Open season for Atlantic cod and white hake in waters adjacent to New Brunswick is from July 11 to August 16 and in waters adjacent to PEI from August 29 to October 4. The Project will likely have a negligible effect on this recreational fishery due to the small PDA and short construction timeframe.

Potential environmental effects on recreational fishing activities are considered negligible due to the short timeframe anticipated for the construction phase of the Project, small PDA compared to the available recreational fishing grounds within the RAA and the limited recreational fishing activity predicted to occur within the PDA. Any restrictions imposed on recreational fishing activities during

Project construction will be short in duration and reversible once construction is complete. Potential environmental effects on recreational fishing activities will therefore not be carried forward in the assessment.

3.2.2.2.3 Aboriginal Fishing

Aboriginal fishing activities take place in two distinct fisheries, the communal commercial fishery, and the Food, Social and Ceremonial (FSC) Fishery. Communal commercial fishery licenses are issued to First Nations communities as a whole and not to individuals. These licenses are commercial licenses that are used for the catch and sale of fish according to the same seasons, gear and quota restrictions that apply to other commercial licenses described above. Communal commercial licenses are therefore included in the evaluation of effects on all commercial fishing activities for the purpose of this assessment.

FSC fishing is a cultural and sustenance activity. DFO negotiates agreements for Aboriginal FSC fishing through the Aboriginal Fisheries Strategy (AFS). DFO recognizes that FSC access to fishery resources has priority over other allocations, provided conservation of the stock is not an issue. Resources fished using an FSC license are used communally to provide food for its members, and support the traditional social and ceremonial activities of the First Nations community or groups (DFO 2012). Potential Project effects on FSC fisheries undertaken by Aboriginal communities are addressed under the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons VC (Section 3.4).

In the RAA, communal commercial fishery licenses have been issued for four species; lobster, herring, scallop, and rock crab. Lobster and herring make up the principal communal commercial fisheries with 89 communal commercial lobster licenses in LFA 25 and 85 communal commercial licenses in HFA 16C/E (Lavoie C, pers. comm., 2015). The communal commercial herring fishery in the RAA is limited to nearshore fishing with gillnets. The scallop and rock crab fisheries make up a much smaller portion of the communal commercial fishery licenses; 24 communal commercial scallop licenses were issued in SFA 22 and 14 communal commercial rock crab licenses were issued in LFA 25. Landings caught under communal commercial licenses are included in species specific totals in the commercial landing information described in the section above.

3.2.3 Project Interactions with Commercial, Recreational and Aboriginal Fisheries

Potential Project interactions with CRA Fisheries are presented in Table 3.17. These interactions are indicated by check marks, and are discussed in Section 3.2.4 in the context of effects pathways, standard and project-specific mitigation/enhancement, and residual effects. Following the table, justification is provided for non-interactions (no check marks).

Table 3.17 Potential Project-Environment Interactions and Effects on Commercial, Recreational and Aboriginal Fisheries

Project Components and Physical Activities	Potential Environmental Effects
	Change in Commercial or Aboriginal Commercial Fishing Activities
Construction	
Site Preparation for Submarine Cable	✓
Installation of the Submarine Cable	✓
Inspection and Energizing of the Submarine Cable	✓
Emissions and Wastes	–
Marine Transportation	✓
Operation	
Energy Transmission	–
Infrastructure Inspection, Maintenance and Repair	✓
Emissions and Wastes	–
Decommissioning and Abandonment	
Decommissioning	✓
Emissions and Wastes	–
Transportation	✓

Notes:
✓ = Potential interactions that might cause an effect.
– = Interactions between the project and the VC are not expected.

Construction

Emissions and wastes are not expected to interact with Commercial, Recreational or Aboriginal fisheries in the area during the construction phase of the Project. Vessels and other equipment that will be used for the installation of the submarine cables are expected to be similar to that of fishing boats and other vessels currently operating within the LAA. Potential effects from emissions and wastes on CRA species are addressed under the Marine Environment VC, Section 3.1. Construction activities with potential interactions are further discussed below in Section 3.2.4.

Operation

Energy transmission will not interact with commercial fishing activities in the PDA. The cables will be buried to a depth of approximately 0.6 m in areas with a water depth of greater than 12 m; in areas with less than 12 m water depth, the cables will be buried approximately 1.6 m. This will provide protection against ice scour and fishing activities. Fishing activities will be permitted within the PDA post-construction and fishers will not be held responsible in the event that fishing gear comes into contact with the submarine cables.

Emissions and wastes from any Project phase will not interact with commercial fisheries. In particular, EMF generated during operation will not interact with commercial species and is discussed in detail in the Section 3.1, Marine Environment VC. Activities during operation with potential interactions are further discussed below in Section 3.2.4.

Decommissioning and Abandonment

Decommissioning and abandonment will be assessed at the end of the useful life of the Project. The life of the Project is 40 years, at which time it may be decommissioned; however, it is more likely that at that time the Project will be refurbished and will continue to operate on a similar basis in perpetuity. If decommissioning activities are determined to be necessary, it is likely that the cables in the marine environment will be abandoned in place to avoid disturbance of the habitat. Given that the cables are solid dielectric and do not contain oil or other harmful chemicals that could leach into the environment or released if the abandoned cable were damaged, there is no expected interaction with this VC. Any decisions made regarding decommissioning and abandonment will be completed in accordance with the applicable regulations at that time and could include either the abandonment or removal of the submarine cable.

3.2.4 Assessment of Residual Environmental Effects on Commercial, Recreational and Aboriginal Fisheries

Potential residual effects on CRA Fisheries include a change in commercial or Aboriginal commercial fishing activities within the LAA due to construction and operation activities.

Potential residual environmental effects on CRA fish species are discussed in the Marine Environment VC (Section 3.1).

3.2.4.1 Analytical Assessment Techniques

The potential environmental effects were assessed based on current regional fisheries statistics and information provided by DFO through correspondence and data requests. The information provided was used to determine existing fishing activities and conditions within the RAA and the subsequent potential interactions between commercial fishing activities and the Project.

3.2.4.2 Assessment of Change in Commercial Fishing Activities

3.2.4.2.1 Project Pathways for Change in Commercial or Aboriginal Fishing Activities

The Project could result in a change in CRA Fisheries within the LAA if construction timeframes and schedules are not able to avoid commercial fishing seasons. A change in commercial or Aboriginal commercial fishing activities within the LAA may include a temporary loss of access to fishing grounds during a fishing season due to navigational hazards associated with construction of the Project which could restrict fishers from placing gear within the PDA or harvesting the resource at expected levels.

A change in commercial or Aboriginal commercial fishing activities may occur during maintenance components of the operational phase of the Project if the associated work overlaps with commercial fishing seasons and result in a temporary loss of access to fishing grounds.

3.2.4.2.2 Mitigation for Change in Commercial or Aboriginal Commercial Fishing Activities

Mitigation measures to reduce the potential environmental effect of a change in commercial or Aboriginal commercial fishing activities are described below.

Construction

- Liaison and communications will continue with local fishing associations and Aboriginal commercial licensees to keep fishers informed of project or construction delays and potential Project – fishing interactions.
- Marine based construction activities will be scheduled, when feasible, to avoid overlap with commercial fishing seasons in the RAA by attempting to complete these Project activities within the commercial fishing off seasons.
- If construction activities must be scheduled during commercial fishing seasons, liaison and communication will continue to manage and reduce adverse conflicts with fishers in the LAA.
- The Canadian Coast Guard will be informed of submarine cable associated work and a Notice to Mariners and/or a Notice to Shipping may be issued to alert vessel traffic of any changes within the region such as exclusion zones around Project vessels to allow for safe navigation of vessel traffic.
- Navigational charts will be updated post construction to include the location of the submarine cables.

Operation

- Routine inspection and maintenance activities will be scheduled, when feasible, to avoid overlap with commercial fishing seasons in the RAA by attempting to complete these Project activities within the commercial fishing off seasons.
- The Canadian Coast Guard will be informed of submarine cable associated work and a Notice to Mariners and/or a Notice to Shipping may be issued to alert vessel traffic within the region.

3.2.4.2.3 Residual Project Environmental Effect for Change in Commercial or Aboriginal commercial fishing Activities

Construction

A residual environmental effect leading to a change in commercial or Aboriginal commercial fishing activities may occur during construction of the Project. Construction will be scheduled to avoid, when feasible, commercial fishing seasons within the RAA. However in the event of delays or disruptions to project schedules, construction may interact with commercial fishing activities within the LAA. It is reasonable to assume that potential interactions will be short in duration and confined to the LAA. With the implementation of mitigation measures such as effective implementation of the Fisheries Liaison and Communication Plan, the magnitude of the effect of the Project on commercial or Aboriginal commercial fishing effort in the LAA is anticipated to be low. This potential effect on commercial or Aboriginal commercial fishing effort is anticipated to occur irregularly during the construction of the Project. Based on existing conditions and past evidence, this environmental effect is anticipated to be reversible and short in duration. After completion of Project construction it is expected that fishing activity and effort within the LAA will return to normal conditions.

Operation

A residual environmental effect leading to a change in commercial or Aboriginal commercial fishing activities may occur during operation of the Project. Routine maintenance activities of the submarine cable will be scheduled, when feasible, during commercial fishing off seasons however in the event commercial fishing seasons are unable to be avoided interactions with commercial fishing seasons may be unavoidable. It is reasonable to assume that potential inspection and maintenance activities will be short in duration and confined to a small section of the PDA. With the implementation of mitigation measures such as the Fisheries Liaison and Communication Plan, the magnitude of the effect of the Project on commercial or Aboriginal commercial fishing effort in the LAA is anticipated to be low. This potential effect on commercial or Aboriginal commercial fishing effort is anticipated to occur irregularly during Project operation. Based on existing conditions and past evidence, this environmental effect is anticipated to be reversible and short in duration.

3.2.4.3 Summary of Residual Project Environmental Effects

The residual Project environmental effects for CRA Fisheries are summarized in Table 3.18.

Table 3.18 Summary of Project Residual Environmental Effects on Commercial, Recreational and Aboriginal Fisheries: Northumberland Strait

Residual Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Commercial or Aboriginal Commercial Fishing Activities	C	A	L	LAA	ST	IR	R	U
Change in Commercial or Aboriginal Commercial Fishing Activities	O	A	L	LAA	ST	IR	R	U

KEY

See Table **Error! Reference source not found.**3.15 for detailed definitions.

Project Phase:
C: Construction
O: Operation
D: Decommissioning and Abandonment

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
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent

NA: Not 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

3.2.5 Determination of Significance

3.2.5.1 Significance of Residual Project Effects

Construction and operation components of the Project may result in a change in commercial or Aboriginal commercial fishing activities within the LAA due to a temporary reduction or loss in access to fishing grounds in the event that activities cannot be scheduled to avoid fishing seasons. A significant adverse residual environmental effect would occur if commercial or Aboriginal commercial fishers were to be displaced or unable to access substantial portions of the fishing areas currently used for all or most of a particular fishing season.

A change in commercial fishing activities within the LAA is not expected to be significant provided mitigation measures are implemented and in consideration of the following.

- Scheduling guidelines will prevent, when feasible, overlap of Project physical activities with commercial fishing seasons. In the event of overlap between Project components and commercial or Aboriginal commercial fishing activities, potential interactions will be managed through continued liaison and Communication with the local fishers.
- The small size of the PDA compared to the available fishing grounds within the RAA.
- The short timeframe anticipated for the completion of the construction and maintenance activities of the Project.
- Updated navigational charts with submarine cable locations and associated hazards.

Overall, the residual adverse environmental effects on commercial or Aboriginal commercial fisheries are considered to be not significant.

3.2.6 Prediction Confidence

Confidence in the predictions of potential environmental effects on CRA fisheries is high due to the availability of fisheries data for the region, understanding of the potential environmental effect pathways, and anticipated effectiveness of the mitigation and project planning measures.

3.2.7 Follow-up and Monitoring

There is no follow up or monitoring proposed for this VC.

3.3 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON HERITAGE RESOURCES

Heritage Resources are those resources, both human-made and naturally occurring, related to human 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 they are present, their integrity is highly susceptible to construction and ground-disturbing activities. Heritage Resources has been selected as a valued component (VC) in recognition of the interest of: regulatory agencies who are responsible for the effective management of these resources within the Project Development Area (PDA) (Northumberland Strait); the general public; and Aboriginal groups that have an interest in the preservation and management of heritage resources related to their history and culture.

Within the Northumberland Strait, heritage resources are any physical remnants found on or below the sea floor that inform us of past human use of, and interaction with, the marine environment. Marine heritage resources include marine archaeological sites (i.e., a site that is fully or partially submerged or that lies below or partially below the high-water mark of any body of water) as well as shipwrecks or abandoned vessels and objects/features associated with New Brunswick and/or PEI's maritime history that are located in the marine setting.

Any Project activity that includes surface or sub-surface seabed disturbance has the potential for interaction with Heritage Resources if they are present. Construction represents the Project phase with the greatest potential for interaction with Heritage Resources due to seabed disturbance during the installation of the submarine cable.

From documentary research carried out in support of the Project (AAS 2014; Archaeological Services 2014a, 2014b), and the review of underwater video footage and sidescan sonar (SSS) footage, there were no known heritage resources in the PDA.

3.3.1 Scope of Assessment

This section defines the scope of the EIA of Heritage Resources in consideration of the regulatory setting, potential Project-VC interactions, and the existing knowledge of the PDA.

3.3.1.1 Regulatory and Policy Setting

Jurisdiction for Heritage Resources in the marine environment rests under federal authority; however, consideration has been made within this VC for provincial guidelines regarding the heritage resources in a submerged context. Heritage Resources in the marine context are protected under two separate federal Acts:

- the *Historic Sites and Monuments Act* (e.g., National Historic Places)
- the *Canada Shipping Act* (i.e., if wrecks of heritage value are identified)

This legislation only applies in the context of documented heritage resources; thus, for the purposes of this assessment no further consideration of federal legislation is required as there are no documented heritage resources within the marine portion of the PDA.

In the PEI context, heritage resources are legislated through the *Archaeology Act* and *Heritage Places Protection Act*, and are regulated by Archaeology Branch, Aboriginal Affairs Secretariat, Government of Prince Edward Island.

- *Archaeology Act* – protection is afforded by the Province for archaeological sites/objects, palaeontological objects/sites, protected archaeological sites, human remains
- *Heritage Places Protection Act* (HPPA) – protection is afforded by the Province for heritage places, historic resources defined as "…any work of nature or man that is primarily of value of its palaeontological, archaeological, prehistoric, cultural, natural, scientific or aesthetic nature." Section 1(b).

Section 8(1) of the HPPA outlines the Minister's authority to "…require any person proposing a development that may adversely affect any designated site, structure or area to provide, at the expense of that person, a heritage impact statement which specifies in detail the expected effect of the development."

Known heritage resources in New Brunswick are regulated under the *Heritage Conservation Act*. The regulatory management of heritage resources falls under the New Brunswick Department of Tourism, Heritage and Culture, and is overseen by its Heritage Branch. Within the Heritage Branch are the offices of Archaeological Services; Historic Places; and the New Brunswick Museum.

The review for Heritage Resources has been undertaken through the completion of historical, archaeological, architectural, and palaeontological research. The Province of New Brunswick provides some guidance for conducting heritage assessments, such as the *Guidelines and Procedures for Conducting Professional Archaeological Assessments in New Brunswick* (the Archaeological Guidelines) (Archaeological Services 2012).

The focus of this VC is archaeological resources in a submerged context (*e.g.*, shipwrecks) that may be located within the PDA for the submarine cable corridor. As there is a low likelihood for the discovery of built heritage resources or paleontological resources in the marine environment, these resources are not considered further in this VC.

3.3.1.2 The Influence of Consultation and Engagement on the Assessment

Consultation has taken place for the land-based VCs for Heritage Resources in New Brunswick and PEI (see New Brunswick and PEI volumes, respectively)). No specific consultation has taken place for the Northumberland Strait as no marine heritage resources have been documented in the PDA.

3.3.1.3 Potential Environmental Effects, Pathways and Measurable Parameters

The environmental assessment of Heritage Resources focuses on the following effect:

- Change in Heritage Resources

The effect has been selected in recognition of the interest of regulatory agencies, the general public as a whole, and potentially affected Aboriginal groups First Nations that have an interest in the preservation and management of Heritage Resources related to their history and culture. Federally, the assessment of Heritage Resources is required based on its inclusion in the definition of environmental effect within the *Canadian Environmental Assessment Act, 2012* (*CEAA 2012*):

> *"5. (1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are…*
> *(c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on…*
>
> > *(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance…*

> *5. (2) However, if the carrying out of the physical activity, the designated project or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under any Act of Parliament other than this Act, the following environmental effects are also to be taken into account…*
>
> *(b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on…*
>
> - *(iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance." (CEAA 2012)*

The measurable parameter used for the assessment of change in Heritage Resources, and the rationale for its selection, is provided in Table 3.19.

Table 3.19 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Heritage Resources

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Heritage Resources	• Disturbance or alteration of whole or part of a heritage resource from project ground disturbance during construction.	• Presence of heritage resource confirms an interaction, and absence indicates any discovery (unplanned) would be an accident.

3.3.1.4 Boundaries

3.3.1.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of Heritage Resources are defined below.

- Project Development Area (PDA): The PDA is a 220 m wide corridor extending approximately 16.5 km between Borden-Carleton and Cape Tormentine. This includes the 10 m wide disturbance area for each submarine cable and the 200 m separation distance between the two cable trenches. The actual area of physical disturbance during construction is approximately 33 ha.
- Local Assessment Area (LAA): The LAA includes the PDA area and extends 1 km on either side of the PDA; the LAA is the maximum area where Project-specific environmental effects can be predicted and measured with a reasonable degree of accuracy and confidence.
- The Regional Assessment Area (RAA): The RAA is the area within which the Project's environmental effects may overlap or accumulate with the environmental effects of other projects or activities. As the potential environmental effects on Heritage Resources are limited to the footprint of physical disturbance associated with the Project for this component, the RAA for Heritage Resources is the Northumberland Strait between the high water lines in New Brunswick and PEI.

3.3.1.4.2 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on Heritage Resources include the Project construction phase as that is the only phase where ground-disturbing activities associated with the Project will be conducted.

Total construction time in the marine environment will take place over a 20 to 25 week period. Pre-trenching in water less than 12 m is scheduled to be conducted from May to early July 2016, while the remaining trenching and cable installation are scheduled to be installed in October and November 2016. Operation will begin following construction and is anticipated to continue for the life of the Project (approximately 40 years). Decommissioning and abandonment would take place following the useful service life of the Project and would be carried out in accordance with regulations in place at that time.

3.3.1.5 Residual Environmental Effects Description Criteria

Table 3.20 provides the environmental effects classification criteria that are used to characterize and describe Project residual environmental effects on Heritage Resources.

Table 3.20 Characterization of Residual Environmental 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. **Neutral**—no net change in measurable parameters for Heritage Resources relative to baseline.
Magnitude	The amount of change in measurable parameters or 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 measureable change to Heritage Resources. **High**—a measureable 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 an environmental effect occurs.	**PDA**—residual effects are restricted to the PDA.
Frequency	Identifies when 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).

Table 3.20 Characterization of Residual Environmental Effects on Heritage Resources

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 condition, or the 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 its existing condition.
Reversibility	Pertains to 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 environmental 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 (*e.g.,* active and historic scallop dragging on the Northumberland Strait).

3.3.1.6 Significance Definition

A significant adverse residual environmental effect on Heritage Resources is one that results in a permanent Project-related disturbance to, or destruction of, all or part of a heritage resource (i.e., archaeological, architectural or palaeontological resource) considered by the provincial heritage regulators and other stakeholders to be of major importance due to factors such as rarity, undisturbed condition, spiritual importance, or research importance, and that cannot be mitigated or compensated.

3.3.2 Existing Conditions for Heritage Resources

3.3.2.1 Methods and Sources of Information

As part of existing conditions research for land-based portions of the Project in NB (Volume 3, Section 3.6) and PEI (Volume 2, Section 3.3), archaeological site searches were conducted for the waters within the Northumberland Strait. The following was also reviewed for the presence of any heritage resources-related features of note within the PDA: underwater video for a portion of the PDA; SSS footage; marine magnetometer surveys; and bathymetric maps (CSR 2015). Further information on the type of equipment used for the marine-based surveys can be found in Section 3.1 and in CSR (2015). Minimum SSS standards as required by New Brunswick Archaeological Services (Appendix F of the Archaeological Guidelines (2012)) were used for all SSS footage collected for the Project.

3.3.2.2 Overview of Existing Conditions

The heritage resource research has been summarized for New Brunswick (Volume 3, Section 3.6) and PEI (Volume 2, Section 3.3) and concluded that no archaeological or heritage resource sites are located within the PDA for the Project components and activities located in the Northumberland Strait. The closest recorded heritage resources are three suspected shipwrecks located near the New Brunswick landfall of the Confederation Bridge, between approximately 3 and 6 km from the PDA for this Project.

The review of SSS, marine magnetometer surveys, and bathymetric maps determined that there is one unknown underwater linear feature located near the Borden-Carleton end of the of corridor at KP 15.5 and a number of magnetic anomalies on both the New Brunswick and PEI side of the cable corridors. It is notable that there are few magnetic anomalies in the middle of the route, where the depth of the water is greatest. Underwater video footage of the unknown linear feature suggests the feature is likely a boulder pile or pile of concrete. Due to its location nearshore on the PEI side of the Northumberland Strait, and the historic prevalence of scallop dragging activities, it is not anticipated that this feature is the result of a deliberate human effort or a heritage resource. Magnetic anomalies present in the magnetometer survey are likely the result of the magnetometer being pulled quite close to the seabed and likely resulted from a detection of debris from fishing and other vessels and do not appear to be heritage resources.

Underwater video of a portion of the seafloor within the PDA (not associated with either cable bed) identified a number of small objects (e.g., a teapot, a glass bottle, and a wooden board) that will be avoided by Project infrastructure. While it is not possible to date these artifacts, they are not concentrated in one location and do not appear to be the result of a shipwreck and are likely just debris cast or lost overboard from passing vessels. Additional inshore underwater video in the PDA on the NB side was collected in August 2015 but the review was not completed by the time this report was prepared. The results will be provided in the Final Archaeological report as part of the NB Arch Service Archaeological permit.

In general, the area of the PDA within the Northumberland Strait has been subject to recent and historic scallop-dragging operations (see Section 3.2). As identified in CSR (2015), seafloor ice scouring is evident and locally abundant near-shore in NB and PEI.

3.3.3 Project Interactions with Heritage Resources

Potential Project interactions with Heritage Resources are presented in Table 3.21. These interactions are indicated by check marks, and are discussed in Section 3.3.6 in the context of effects pathways, standard and project-specific mitigation/enhancement, and residual effects. Following the table, justification is provided for non-interactions (no check marks).

Table 3.21 Potential Project-Environment Interactions and Effects on Heritage Resources

Project Components and Physical Activities	Potential Environmental Effects
	Change in Heritage Resources
Construction	
Site Preparation for Submarine Cable	✓
Installation of the Submarine Cable	✓
Inspection and Energizing	–
Emissions and Wastes	–
Marine Transportation	–
Operation	
Energy Transmission	–
Infrastructure Inspection, Maintenance and Repair	–
Emissions and Wastes	–
Decommissioning and Abandonment	
Decommissioning	–
Emissions and Wastes	–
Transportation	–

Notes:
✓ = Potential interactions that might cause an effect.
– = Interactions between the project and the VC are not expected.

Construction

Potential interactions during Project construction phase are limited to ground-disturbing activities. Site preparation and installation of the cable are discussed in further detail in the sections below.

Operation

Once the submarine cable is installed, activities during operation will not affect Heritage Resources as these activities will not result in ground disturbance.

Decommissioning and Abandonment

The life of the Project is 40 years, at which time it may be decommissioned; however, it is more likely that at that time the Project will be refurbished and will continue to operate on a similar basis in perpetuity. If decommissioning activities are determined to be necessary, it is likely that the cables in the marine environment will be abandoned in place to avoid disturbance of the habitat. There are no expected interactions with Heritage Resources during any potential decommissioning activities as any disturbance would be occurring in areas that were previously disturbed during cable installation.

3.3.4 Assessment of Residual Environmental Effects on Heritage Resources

Construction activities as identified in Table 3.21 are the only Project activities with potential to result in residual environmental effects of the Project on Heritage Resources. These interactions, pathways, mitigation and residual effects are described below.

3.3.4.1 Analytical Assessment Techniques

Analytical techniques for the marine environment are limited to the review of background research and archaeological site maps for the land-based portions of the Project in the New Brunswick (Volume 3, Section 3.6) and PEI (Volume 2, Section 3.3), the review of SSS footage of the entire submarine cable corridor, and the review of underwater video footage within portions of the PDA for the submarine cable corridor.

3.3.4.1.1 Project Pathways for Heritage Resources

Heritage Resources in the marine environment (i.e., submerged archaeological resources) would be located on the seafloor, thus, the interaction with Heritage Resources is expected to take place during ground-disturbing activities such site preparation for the submarine cable and installation of the submarine cable.

As there were no Heritage Resources (i.e., submerged archaeological resources) identified within the marine environment during existing conditions research it is anticipated there will be no interaction with Heritage Resources during construction activities.

3.3.4.1.2 Mitigation for Heritage Resources

As there were no submerged archaeological resources identified during research, mitigation for Heritage Resources is limited to:

- Development of an archaeological response protocol in the event of accidental discovery of submerged archaeological resources during construction activities which will be part of the marine EPP.

3.3.4.2 Residual Project Environmental Effects for Change in Heritage Resources

The assessment of potential effects to Heritage Resources was compiled using background research and an archaeological visual assessment of the PDA. The background research included a review of the locations of any known archaeological sites, plane crashes and submerged marine vessels. This information was received from the regulators at Aboriginal Affairs, Province of Prince Edward Island and Archaeological Services, Province of New Brunswick. The archaeological assessment was undertaken in June 2015 and involved reviewing video footage and side scan sonar data of existing conditions within the PDA in order to determine the presence or absence of heritage resources.

3.3.4.3 Summary of Residual Project Environmental Effects

The residual Project environmental effects on Heritage Resources are summarized in Table 3.22 and discussed below.

Table 3.22 Summary of Project Residual Environmental Effects on Heritage Resources

Residual Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Heritage Resources	C	A	L/M	PDA	P	S	I	D

KEY
See Table 3.20 for detailed definitions.

Project Phase:
C: Construction
O: Operation
D: Decommissioning and Abandonment

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
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent

NA: Not applicable

Frequency:
S: Single event

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

3.3.5 Determination of Significance

3.3.5.1 Significance of Residual Project Effects

Construction activities as identified in Table 3.21are the only Project activities with potential to result in environmental effects on Heritage Resources. With mitigation, consisting of the development and implementation of an archaeological response protocol for the Project, the potential residual adverse environmental effects of the construction of the Project on Heritage Resources are rated not significant.

3.3.6 Prediction Confidence

The prediction of significance of Project effects on Heritage Resources has been made with a high level of confidence due to the comprehensiveness of the background research for land-based portions of the Project in New Brunswick (Volume 3, Section 3.6) and PEI (Volume 2, Section 3.3), and archaeological research for the waters within the Northumberland Strait.

3.3.7 Follow-up and Monitoring

There are no suggested follow-up and monitoring activities for Heritage Resources.

3.4 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS ON CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES BY ABORIGINAL PERSONS

Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons was selected as a VC in accordance with the requirements of the *Canadian Environmental Assessment Act* (2012) which states that the effect of any change that may be caused to the environment on the current use of land and resource for traditional purposes by Aboriginal persons must be taken into account when conducting an environmental assessment for a project.

For the purposes of this assessment, Current Use is considered "living memory" of the use of land and resources within the PDA. For this VC, current use primarily applies to Aboriginal fishing and hunting in the Northumberland Strait.

This VC is closely related to CRA Fisheries VC (Section 3.2) which addresses Aboriginal commercial communal fishing. It is also closely related to the Marine Environment VC (Section 3.1) which addresses potential biological effects on fish species which may be targeted in a traditional use fishery.

3.4.1 Scope of Assessment

3.4.1.1 Regulatory and Policy Setting

Fisheries Act

Aboriginal fishing activities take place in two distinct fisheries, the communal commercial fishery, and the Food, Social and Ceremonial (FSC) Fishery. The general provisions that are set out under the federal *Fisheries Act* (refer to CRA Fisheries VC Section 3.2) for the communal commercial fishery apply to the FSC in the Northumberland Strait in terms of general protection of CRA species. Provisions under the *Fisheries Act* protect fish and fish habitat, including fisheries resources, and apply specific regulations governing fisheries.

FSC licenses are issued under the authority of the *Fisheries Act* and of subsection 4(1) of the Aboriginal Communal Fishing Licenses Regulations.

Fishery resources are protected from uncontrolled fishing activity through various measures such as area closures, fishing quotas, fishing seasons, and gear and vessel restrictions as described and detailed under the regulations presented above and by Fisheries Management Decisions applied by DFO in accordance with the roles and responsibilities outlined in the *Fisheries Act* (DFO 2013a).

Oceans Act

Other broad mechanisms for the protection of marine resources are provided in the federal Oceans Act which governs the establishment and alteration of fishing zones and Marine Protected Areas within Canadian waters.

3.4.1.2 The Influence of Consultation and Engagement on the Assessment

The Proponent will be engaging with Aboriginal communities in proximity to the Project to identify issues and concerns related to Project development. Details of the Aboriginal engagement plan are presented in Volume 1 (Section 3.2.3). The political leadership (i.e., Chief and Council) within Aboriginal communities in proximity to the Project will be notified of the Project details (e.g., the location, details, and schedule of the Project) via a letter to determine if these communities have any questions or concerns about the Project and determine the need for further engagement to discuss the project. This letter will request information on any known current use of the area within the Northumberland Strait that will be affected by the Project. A meeting regarding the Project was held between MECL and the Mi'kmaq Confederacy in PEI on April 27, 2015.

Consultation with the Fisheries and Oceans Canada (DFO) has identified Aboriginal commercial communal fisheries in the Northumberland Strait; potential interactions between these fisheries and the Project are addressed in the CRA Fisheries VC (Section 3.2.3). Fisheries conducted under the commercial communal licenses are not considered to be current use for traditional purposes by Aboriginal persons for the purpose of this VC.

3.4.1.3 Potential Environmental Effects, Pathways and Measurable Parameters

The Project could have an effect on traditional activities where they occur in proximity to the PDA, and there is the potential for an interaction to cause a change in current use of marine waters and resources for traditional purposes.

During the phases of the Project, (construction, operation and decommissioning and abandonment) there may be a period of time where access to fishing/gathering/hunting grounds is restricted within a localized area. Construction and operation activities will require marine vessel activities that may temporarily disrupt fishing or hunting activities in the Strait. Decommissioning and abandonment will be assessed at the end of the useful life of the Project. The life of the Project is 40 years, at which time it may be decommissioned; however, it is more likely that at that time the Project will be refurbished and will continue to operate on a similar basis in perpetuity. If decommissioning activities are determined to be necessary, it is likely that the cables in the marine environment will be abandoned in place to avoid disturbance of the habitat. Any decisions made regarding decommissioning and abandonment will be completed in accordance with the applicable regulations at that time and could include either the abandonment or removal of the submarine cable.

The potential effect of changes in populations of marine species is discussed in the Marine Environment VC (Section 3.1.4). The results of the assessment of potential Project effects on those resources that may be used for tradition purposes will help to inform the assessment of potential interactions on Current Use of Land and Resources for Tradition Purposes by Aboriginal Persons.

Table 3.23 outlines the potential environmental effects, pathways and measurable parameters associated with the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons as they relate to this Project.

Table 3.23 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Current Use of Marine Waters and Resources for Traditional Purposes by Aboriginal Persons	• Temporary or permanent loss of access to fishing, hunting or gathering areas or opportunities. The Project may change the health or habitat of traditionally harvested species.	• Duration of time that fishing, hunting and gathering is not able to be conducted. • Documented current use resources for traditional purposes by Aboriginal persons.

3.4.1.4 Boundaries

3.4.1.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of Current Use of Land and Resources for Traditional Purposes by Aboriginal Person are presented in Figure 3.11 and defined below.

- Project Development Area (PDA): The PDA is a 220 m wide corridor extending approximately 16.5 km between Borden-Carleton and Cape Tormentine. This includes the 10 m wide disturbance area for each submarine cable and the 200 m separation distance between the two cable trenches. The actual area of physical disturbance during construction is approximately 33 ha.
- Local Assessment Area (LAA): The LAA includes the PDA area and extends 1 km on either side of the PDA; the LAA is the maximum area where Project-specific environmental effects can be predicted and measured with a reasonable degree of accuracy and confidence

- Regional Assessment Area (RAA): The RAA includes the marine waters within the administrative boundaries of LFA 25. The RAA was defined as LFA 25 because all Project activities fall within this commercial fishing administrative boundary. SFA 22 and GFA 4T7 maintain the same geographical boundaries as LFA 25. Included within the RAA are sections of the commercial fishing administrative boundaries of HFA 16E and MFA 16. While these general fishing areas were selected to represent the potential RAA for current use activities, the proponent acknowledges that potential current use activities may not be limited to this area.

3.4.1.4.2 Temporal Boundaries

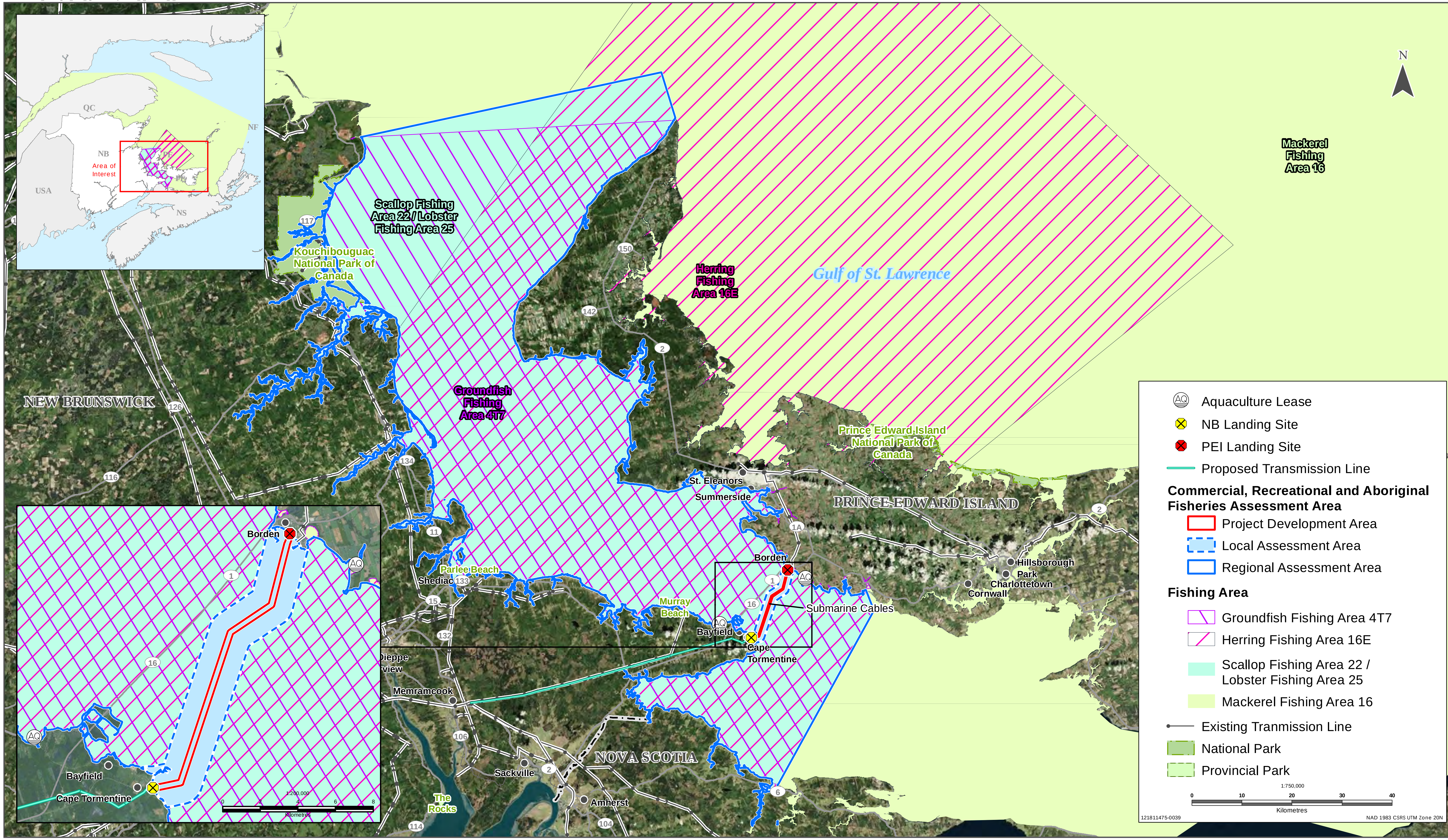
The temporal boundaries for the assessment of the potential effects of the Project on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons include the construction, operation and decommissioning and abandonment phases of the Project. Total construction time in the marine environment will take place over a 20 to 25 week period. Pre-trenching in water less than 12 m is scheduled to be conducted from May to early July 2016, while the remaining trenching and cable installation are scheduled to be installed in October and November 2016. Operation will begin following construction and is anticipated to continue for the life of the Project (approximately 40 years). Decommissioning and abandonment would take place following the useful service life of the Project and would be carried out in accordance with regulations in place at that time.

The temporal boundaries of existing conditions for the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons is the period of "living memory" of Aboriginal Persons or communities engaged in current use activities within the Strait.

Temporal boundaries pertain to the periods of time the traditional activities (e.g., fishing, hunting, gathering) are pursued, as well as any seasonal limitations associated with terms of food, social, and ceremonial (FSC) licenses.

3.4.1.5 Residual Environmental Effects Description Criteria

Table 3.24 provides the environmental effects classification criteria that are used to characterize and describe Project residual environmental effects on the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons.



Sources: GeoNB, NB Power, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons Assessment Boundaries

Figure 3.11

Table 3.24 Characterization of Residual Environmental Effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

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 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons relative to baseline. **Adverse**—an effect that moves measurable parameters in a direction detrimental to Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons relative to baseline. **Neutral**—no net change in measureable parameters for the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons relative to baseline.
Magnitude	The amount of change in measurable parameters or variable relative to existing conditions.	**Negligible**—no measurable change from existing baseline conditions. **Low**—a measurable change from existing baseline conditions, but results in no net loss in the availability of or access to water and/or resources currently used for traditional purposes. **Moderate**—measurable change (but less than high) from existing baseline conditions, in the availability of or access to water and/or resources currently used for traditional purposes. **High**—measurable change from existing baseline conditions that is a non-compensated substantive and permanent loss in the availability of or access to water and/or resources currently used for traditional purposes.
Geographic Extent	The geographic area in which an environmental, effect occurs.	**PDA**—residual effects are restricted to the PDA. **LAA**—residual effects extend into the LAA. **RAA**—residual effects interact with those of other projects in the RAA.
Frequency	Identifies when the residual effect occurs and how often during the Project or in a specific phase.	**Single event**—effect occurs once during the construction and operation phases of the Project. **Multiple irregular event**—occurs at irregular intervals during construction and infrequently during the operation phases of the Project. **Multiple regular event**—occurs at regular intervals during the operation phases of the Project. **Continuous**—occurs continuously during the construction and operation phases of the Project.

Table 3.24 Characterization of Residual Environmental Effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter or the Use of Land and Resources for Traditional Purposes by Aboriginal Persons returns to its existing condition, or the effect can no longer be measured or otherwise perceived.	**Short-term**—residual effect restricted to the construction period (effects are measurable for days to a few months). **Medium-term**—residual effect extends throughout the construction and up to 40 years during operation. **Long-term**—residual effect extends beyond the life of the project.
Reversibility	Pertains to whether a measurable parameter can return to its existing condition after the project activity ceases.	**Reversible**—the effect is likely to be reversed after activity completion and reclamation. **Irreversible**—the effect is unlikely to be reversed.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental 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.

3.4.1.6 Significance Definition

A significant adverse residual environmental effect on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons is defined as a long-term (loss of an entire season) loss of the availability of, or access to, land and water resources for use. In particular it includes the loss of the availability of, or access to, water resources, the aquatic environment and ceremonial sites located within the assessment area by Aboriginal persons for traditional purposes and cannot be mitigated.

3.4.2 Existing Conditions for Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

3.4.2.1 Methods

Information regarding Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons in the Northumberland Strait was obtained through review of existing literature, online public resources, engagement with stakeholders and formal data requests.

Engagement activities in Aboriginal communities in New Brunswick and PEI have been initiated and will be on-going. The exact nature, scope and detail of these engagement activities will be determined with community leaders.

Relevant information in this section is derived from relevant biophysical assessments, literature review, past project experience, and professional judgment. In particular the assessment of traditional use has been informed by other VC assessments, primarily Marine Environment VC (Section 3.1), which addresses fish species which may be targeted in a traditional use fishery. The assessments of effects on fish species may not capture the conditions that influence the act of harvesting (e.g., personal choice). However, the abundance of a species that may be used for traditional purposes and the potential effects on that abundance by the Project will directly affect the current use of that species for traditional purposes.

3.4.2.2 Overview

The following is a summary of historical and current use by First Nations from research and literature. As additional information becomes available through the engagement process, it will be provided in supplemental reports (if applicable).

Mi'kmaq traditional territory (Figure 3.12) is understood to be comprised of all of Nova Scotia and PEI and the eastern shore of New Brunswick, extending north to the Gaspe. Mi'kmaq territory in New Brunswick extends west, where it meets the neighboring Maliseet traditional territory, the divide with which is generally seen as the drainage area of the Saint John River watershed as far north as the Gulf of St. Lawrence and south to the Bay of Fundy (Paul n.d.; Berneshawi 1997).

There are fifteen First Nations communities within the province of New Brunswick and two First Nation communities on Prince Edward Island. These are comprised of six Maliseet Nation communities and eleven Mi'kmaq Nation communities (Figure 3.13). Based on ethno-historical accounts, oral histories, archaeological research, and historical texts, the Maliseet and Mi'kmaq Nations and their ancestors have lived and use the land and resources of what is now New Brunswick and Prince Edward Island since the retreat of the glaciers in this area.

There are two Mi'kmaq First Nation communities within PEI, Lennox Island and Abegweit. Lennox Island First Nation is located along the northwestern coastal region of the province (Lennox Island First Nation 2013). Abegweit First Nation consists of three reserves in different geographic locations on the eastern portion of the province (Morell Rear Reserve #2, Rocky Point Reserve #3, and Scotchfort Reserve #4) (Abegweit First Nation 2015). The Mi'kmaq Confederacy of Prince Edward Island (MCPEI) is a common forum for the First Nations in PEI to address issues related to Aboriginal and treaty rights (MCPEI 2015).

Of the 11 Mi'kmaq communities that are geographically located along the Northumberland Strait in New Brunswick and PEI, six communities are located within the RAA: Fort Folly First Nation, Bouctouche First Nation, Elsipogtog First Nation, Indian Island First Nation, Lennox Island First Nation and Abegweit First Nation. Information on these communities is presented in Table 3.25.

Table 3.25 Characteristics of Mi'kmaq Communities within RAA, 2015

Reserve	Size (ha)	Location	Total Population as of January 2015 (On and Off-Reserve)
Fort Folly First Nation			
Fort Folly 1	56.10	61.07 km southwest of PDA	130
Bouctouche First Nation			
Bouctouche 16	62.30	83.2 km northwest of PDA	118
Indian Island First Nation			
Indian Island 28	38.40	97.6 km northwest of PDA	183
Elsipogtog First Nation			
Richibucto 15	1742.10	106.3 km northwest of PDA	3,260
Soegao No. 35	104.5	89.3 km northwest of PDA	
Lennox Island First Nation			
Lennox Island 1	534.2	42.4 km northeast of the PDA	928
Lennox Island 6	9.7	12.8 km north of the PDA	
Lennox Island 5	18.8	44.4 km northeast of the PDA	
Abegweit First Nation			
Morell 2	83	76.6 km east of the PDA	370
Rocky Point 3	4.8	42.4 km east of the PDA	
Scotchfort 4	113.10	61.6 km east of the PDA	
Source: AANDC 2014.			

The PDA is located within traditional Mi'kmaq territory. In the fall of 2014 and spring of 2015 a request for traditional information along with details regarding the Project were provided by email to MCPEI, and the PEI provincial branch of the Aboriginal Affairs Secretariat. This email request for information was sent as part of the archaeological permit application process in order to conduct an archaeological walkover of the Borden-Carleton landfall site. On June 1, 2015, MCPEI responded with a letter stating that based on the information they have, fish harvesting of mackerel occurs in the area to the south of the landfall site. A copy of the letter is included in Appendix A.

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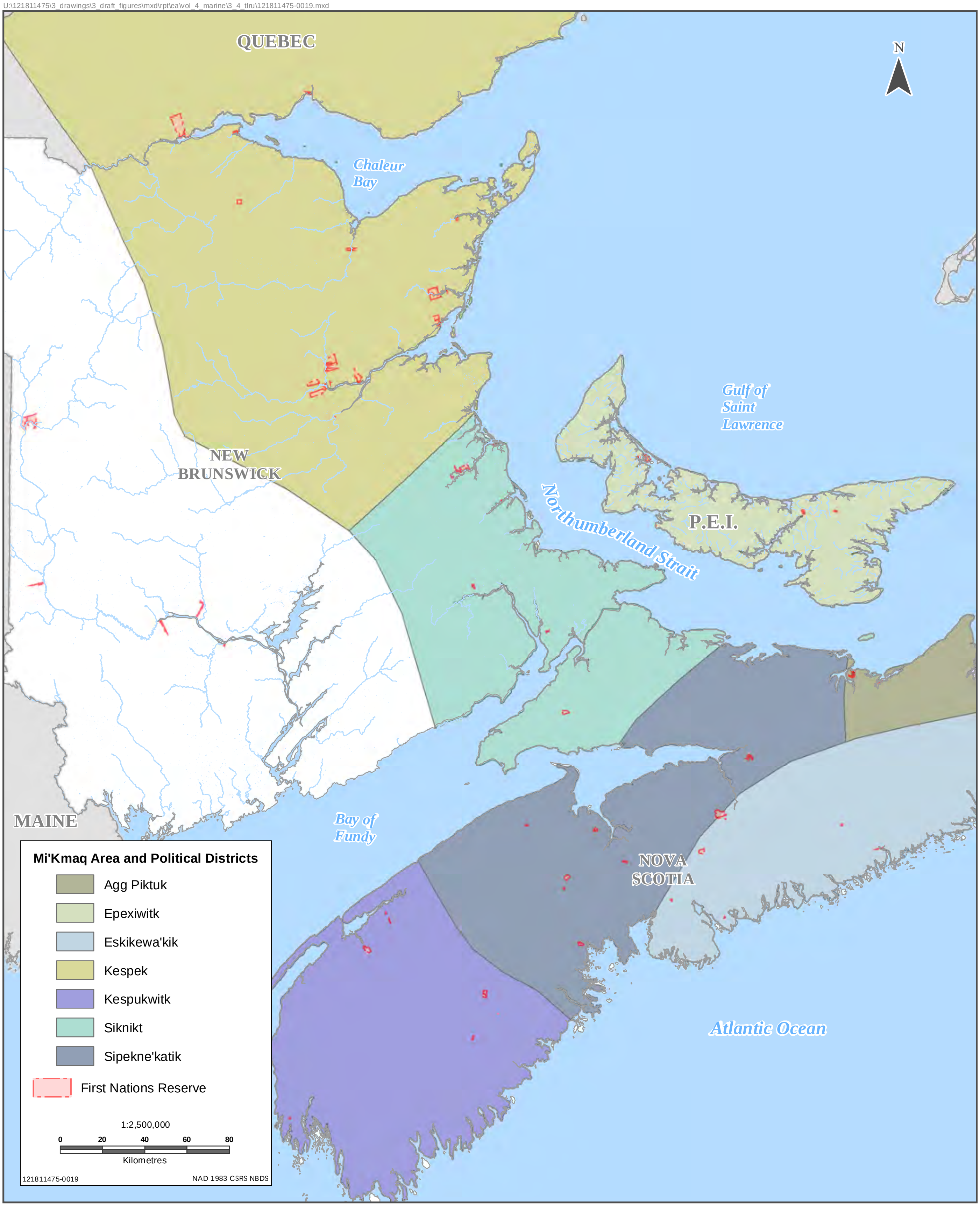

Sources: Base Data - SNB, NBDNR. Mi'Kmaq Areas Data - Paul, Danieln: http://www.danielnpaul.com/Map-Mi'kmaqTerritory.html. Ganong, W.F. 1899. Map of New Brunswick in Prehistory (Indian) Period., Natural Resources (2011).Project Data from Stantec or provided by NB Power / MECL.

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Mi'kmaq Areas in Eastern Canada

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Figure 3.12

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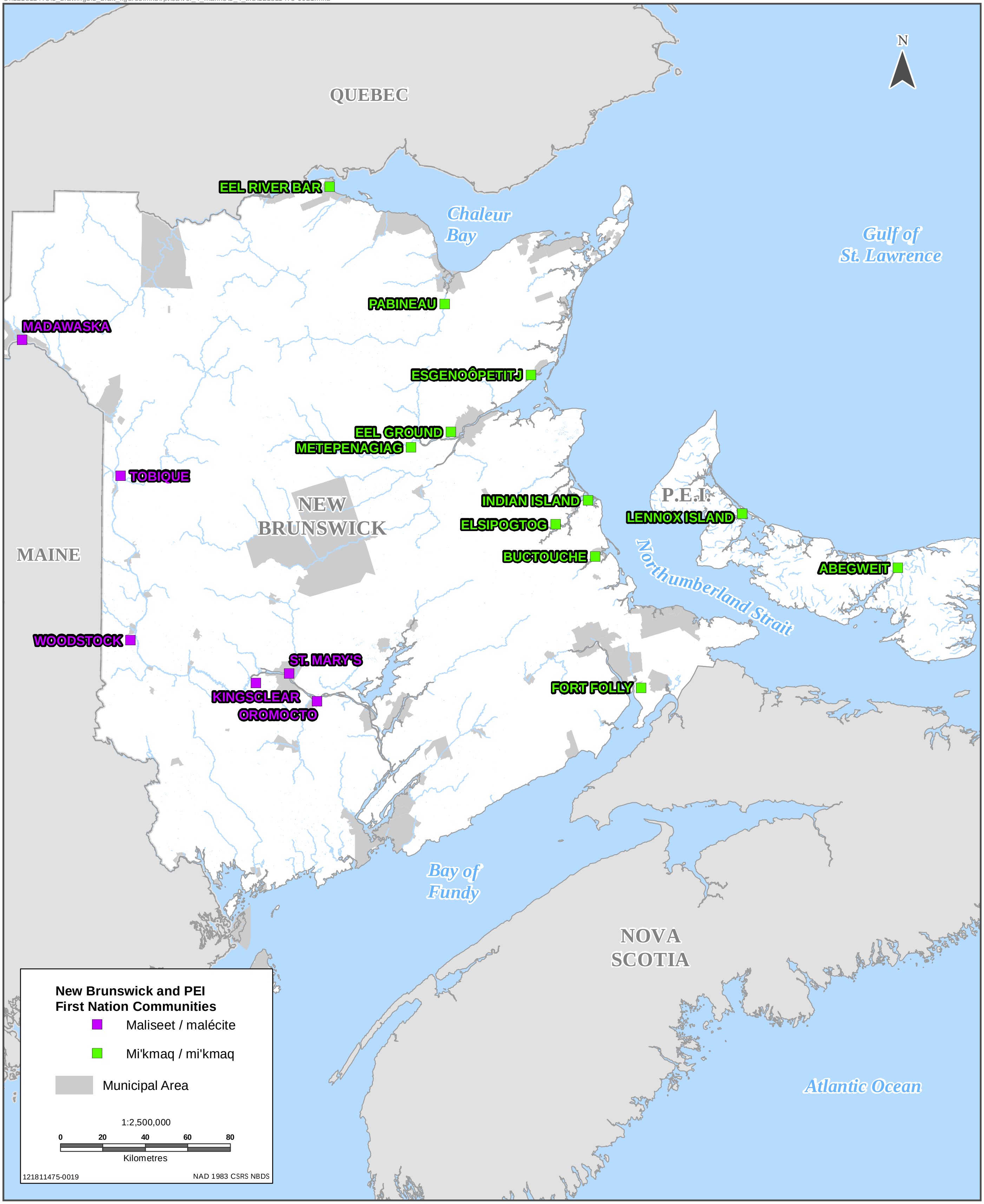

Sources: Mi'Kmaq Areas Data - Paul, Danieln: http://www.danielnpaul.com/Map-Mi'kmaqTerritory.html. Natural Resources (2011).Project Data from Stantec or provided by NB Power / MECL.

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New Brunswick and Prince Edward Island First Nation Communities

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Figure 3.13

Aboriginal fishing activities take place in two distinct fisheries, the communal commercial fishery, and the Food, Social and Ceremonial (FSC) Fishery. Communal commercial fishery licenses are issued to First Nations communities as a whole as opposed to individuals. Since these licenses are commercial licenses, information on the commercial Aboriginal fishery in the Northumberland Strait is presented in the CRA Fisheries VC (Section 3.2) and is not included in this VC as traditional use.

FSC fishing is a cultural and sustenance activity and DFO negotiates agreements for Aboriginal fishing through the Aboriginal Fisheries Strategy (AFS) for FSC purposes. DFO recognizes that FSC access to fishery resources has priority over other allocations, provided conservation of the stock is not an issue. Resources fished using an FSC license are used communally to provide food for its members, and support the traditional social and ceremonial activities of the First Nations community or groups (DFO 2012).

FSC licenses are issued with a variety of conditions on the timing of fishing activities, the location to be fished, the gear to be used and the quantity allocation. The conditions of each FSC license vary from species to species, and within a single species conditions can vary from one license to another. The principal FSC fisheries in the RAA as indicated by number of licenses issued are for bivalves (including clams, oysters, mussels, and scallops), mackerel, and lobster (Lavoie C, pers. comm., 2015).

FSC bivalve harvesting is carried out in the tidal waters of the Northumberland Strait and at locations mutually agreed upon by Aboriginal Groups and DFO. Allocations range from daily individual harvest limits (e.g. 100 to 350 clams per individual per day) to a quantity that is sufficient to meet FSC needs.

FSC mackerel fishing is carried out throughout MFA 16 and at locations mutually agreed upon by First Nations communities and DFO. For some licenses there is not quota for mackerel, for others, allocations are weight based (e.g., 200 lbs), or based on individual net or daily harvest limits.

FSC lobster fishing is carried out throughout LFA 25 and at locations mutually agreed upon by Aboriginal communities and DFO. Allocations range from weight based (e.g., 50,000 lbs) to number of tags per individual, to quantities that are negotiated with DFO on a case per case basis.

An overview of FSC licenses within the RAA is provided in Tables 3.26.

Table 3.26 FSC Licenses issued to Aboriginal communities within the RAA

Species	Number of Licenses	Species	Number of Licenses
Clams	12	Mussels	4
Cod	2	Oysters	6
Eel	2	Quahog	3
Groundfish	1	Rock Crab	5
Halibut	1	Scallops	2

Table 3.26 FSC Licenses issued to Aboriginal communities within the RAA

Species	Number of Licenses	Species	Number of Licenses
Herring	9	Seals	4
Shellfish	2	Silverside	1
Lobster	7	Smelts	6
Mackerel	10	Toad Crab	1

Note: The administrative boundary for herring extends beyond the area described as the RAA (on the Gulf of St. Lawrence side of PEI). The exact number of herring licenses held by Aboriginal people in the Northumberland Strait portion of the RAA is unknown (Leblanc I, pers. comm., 2015).

In addition to the species identified in table 3.26, it is possible that other hunting and gathering activities take place in the Northumberland Strait (e.g., gathering seaweed or other species). Further information on Aboriginal harvesting activities will be gathered throughout the ongoing Aboriginal engagement activities.

3.4.3 Project Interactions with Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Potential Project interactions with Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons are presented in Table 3.27. These interactions are indicated by check marks, and are discussed in Section 3.4.4 in the context of effects pathways, standard and project-specific mitigation/enhancement, and residual effects. Following the table, justification is provided for non-interactions (no check marks).

Table 3.27 Potential Project-Environment Interactions and Effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Project Components and Physical Activities	Potential Environmental Effects
	Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons
Construction	
Site Preparation for Submarine Cable	✓
Installation of the Submarine Cable	✓
Inspection and Energizing of the Submarine Cable	-
Emissions and Wastes	-
Marine Transportation	✓
Operation	
Energy Transmission	-
Infrastructure Management, Maintenance and Repair	✓
Emissions and Wastes	-

Table 3.27 Potential Project-Environment Interactions and Effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Project Components and Physical Activities	Potential Environmental Effects
	Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons
Decommissioning and Abandonment	
Decommissioning	✓
Emissions and Wastes	-
Transportation	✓
Notes: ✓ = Potential interactions that might cause an effect. – = Interactions between the project and the VC are not expected.	

Construction

During the construction phase, the primary interaction with this VC will occur with the site preparation and installation of the submarine cables and generally limited to the PDA. Marine transportation activities during construction will generally be limited to the PDA for a period of less than one season. Fishing activities will not be excluded from the PDA once the submarine cable has been installed and is operational.

Operation

Emissions and wastes (in particular EMF generated during operation) will not interact with commercial fishing activities in the PDA and is discussed in detail in the Section 3.1, Marine Environment VC. Emissions and wastes generated during the construction, when vessels and bottom equipment will be used for the installation or removal of the submarine cables, are expected to be similar to that of fishing boats and other vessels currently operating within the LAA.

Fishing activities will not be excluded from the PDA once the submarine cables have been installed and are operational.

Decommissioning and Abandonment

Decommissioning and abandonment will be assessed at the end of the useful life of the Project. The life of the Project is 40 years, at which time it may be decommissioned; however, it is more likely that at that time the Project will be refurbished and will continue to operate on a similar basis in perpetuity. If decommissioning activities are determined to be necessary, it is likely that the cables in the marine environment will be abandoned in place to avoid disturbance of the habitat. Given that the cables are solid dielectric and do not contain oil or other harmful chemicals that could leach into the environment or released if the abandoned cable were damaged, there is no expected interaction with this VC. Any decisions made regarding decommissioning and abandonment will be completed in accordance with the applicable regulations at that time and could include either the abandonment or removal of the submarine cable.

3.4.4 Assessment of Residual Environmental Effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Potential residual effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons include a change to traditional hunting, fishing or gathering opportunities within the LAA due to construction, operation or decommissioning activities.

Potential residual environmental effects on Aboriginal commercial fisheries are discussed in the CRA Fisheries VC (Section 3.2), and effects on fish species are discussed in the Marine Environment VC (Section 3.1).

3.4.4.1 Analytical Assessment Techniques

Information regarding Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons in the Northumberland Strait was obtained through review of existing literature, online public resources, engagement with stakeholders and formal data requests. The conclusions in this section are derived primarily from the conclusions from relevant biophysical assessments, past project experience, and professional judgment.

3.4.4.2 Assessment of a Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

3.4.4.2.1 Project Pathways for a Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Information provided by DFO indicates that the LAA and surrounding waters are fished for FSC purposes, including mackerel, eel, shellfish (clams, mussels, oysters, quahog) and other species. The subsea cable route is expected to traverse these fishing areas. It is anticipated that construction and operation (maintenance) of the submarine cables may result in a temporary loss of access to areas within the PDA that are used for harvesting through hunting, fishing and gathering. This restricted access to the Project site could constrain Aboriginal fishing, hunting and gathering opportunities.

3.4.4.2.2 Mitigation for a Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Mitigation for effects related to a change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons is closely linked to mitigation measures for CRA Fisheries VC (Section 3.2) and the Marine Environment VC (Section 3.1). It is expected that this mitigation will protect traditional uses such as the FSC fishery. These mitigation measures include:

As a general mitigation measure, FSC liaison and has been implemented and will continue with Aboriginal Communities to keep fishers informed of Project, including scheduling and or construction delays. ,

During Project construction, exclusion zones around Project vessels may be implemented to allow for navigation of vessel traffic.

Once construction of the Project is complete, there will be no fishing exclusion zones or fishing gear restrictions within or around the Project footprint. Fishers will be able to continue to access these fishing grounds and conditions are expected to return to pre-construction levels. This is consistent with what is currently in place for the existing transmission cables between New Brunswick and PEI.

Prior to construction of the Project a Notice to Mariners and Notice to Shipping will be issued in conjunction with the Canadian Coast Guard to inform vessel traffic of Project activities. Navigational charts will be updated post construction to include the location of the submarine cables. The following mitigation measures will be implemented for changes in marine population, and will be applied during Project construction:

- Timing of in-water work will be conducted in consideration of sensitive biological periods (e.g., reproductive life stages), where practical, for CRA species, as determined through discussions with DFO and other regulators.
- Prior to beginning marine works, sediment curtains will be put in place around activities at cable landing sites, if practical, to prevent sediment from entering the water column outside the work area.
- Only clean rock (containing less than 5 % fines and non-acid generating) or native material will be used for infilling (acid generating rock may be used in areas that will be submerged by water at all times).
- Construction vessels will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife.
- Project vessels will comply with applicable legislation, codes and standards of practice for shipping, including the Ballast Water Control and Management Regulations under the *Canada Shipping Act* and the Canadian Ballast Water Management Guidelines, to reduce risk of introduction of marine invasive species.
- Project vessel port of call history and/or records and proof of hull cleaning will be provided prior to entering the Northumberland Strait. Vessel hulls will be cleaned and/or inspected to prior to entering the Northumberland Strait, where necessary.
- Should it be determined that construction activities will result in serious harm to CRA fish or supporting fish species as defined under the *Fisheries Act* and policies a habitat offsetting plan will be prepared for DFO approval and implemented.

The following mitigation measures will be implemented for changes in marine population, and will be applied during Project operation:

- The electrical transmission cables will be completely buried minimizing heat and EMF emissions at the seabed surface.
- Inspection support vessels will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife.

3.4.4.2.3 Residual Project Environmental Effect for a Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

A residual environmental effect leading to a change in Current Use of Land and Resources for Traditional Purposes by Aboriginal persons may occur during construction and operation of the Project. The construction and operation (maintenance) may result in disruptions to access to fishing, hunting and gathering activities within the LAA. It is reasonable to assume that potential interactions will be short in duration and confined to the LAA. With the implementation of mitigation measures such as effective implementation of an FSC Liaison and Communications Plan, the magnitude of the effect of the Project on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons is anticipated to be low. This potential effect on traditional fishing, hunting and gathering activities is anticipated to occur at multiple irregular events during the construction of the Project and is anticipated to occur irregularly during Project operation. Based on existing conditions and past evidence, this environmental effect is anticipated to be reversible and short in duration. After completion of Project construction and operation, it is expected that traditional fishing, hunting and gathering activities within the LAA will return to pre-construction conditions.

3.4.4.3 Summary of Residual Project Environmental Effects

The residual Project environmental effects on Current Use of Land and Resources for Traditional Purposes by the Aboriginal persons are provided in Table 3.28.

Table 3.28 Summary of Project Residual Environmental Effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons: Northumberland Strait

Residual Effect	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socioeconomic Context
Change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons	C	A	L	LAA	ST	I/R	R	U
	O	A	L	LAA	ST	I/R	R	U

KEY
See Table 3.24 for detailed definitions.
Project Phase:
C: Construction
O: Operation
D: Decommissioning and Abandonment
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
RAA: Regional Assessment Area
Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term
P: Permanent

NA: Not 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

3.4.5 Determination of Significance

3.4.5.1 Significance of Residual Project Effects

A change in Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons within the LAA is not expected to be significant during the construction or operation phases of the Project provided mitigation measures are implemented and in consideration of the following:

- The small size of the PDA compared to the available fishing/hunting/gathering grounds within the RAA.
- The short timeframe anticipated for the completion of the construction or operation activities of the Project.

Overall, the residual adverse environmental effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons are considered to be not significant.

3.4.6 Prediction Confidence

Confidence in the conclusions is moderate due to the limited availability of information related to the current use of resources for traditional purposes in the Northumberland Strait. However, regarding the potential environmental effects on marine wildlife, there is a high level of understanding of the potential environmental effect pathways, and anticipated effectiveness of the mitigation and project planning measures. The overall prediction confidence associated with this VC therefore if moderate to high.

As consultation is ongoing, should Traditional Knowledge information become available, this information will be considered and residual effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons will be reviewed. Given the qualitative and subjective nature of assessing the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons, the views of Aboriginal groups may differ from this assessment. Should concerns regarding residual effects be identified through ongoing Aboriginal engagement, this information will be provided through additional reporting.

The Proponent will continue to work with the First Nations to reasonably address Project-specific issues related to residual effects, and will take Aboriginal concerns and recommendations into account during the Project planning process.

3.4.7 Follow-up and Monitoring

There is no follow up or monitoring proposed for this VC.

The Proponent will continue to consult with the Aboriginal communities to reasonably address Project-specific issues related to residual effects and additional work and/or monitoring may be required pending the results of the engagement process.

4.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Effects of the environment on the Project are associated with risks of natural hazards and influences of nature on the Project. These effects may arise due to forces associated with weather, climate, climate change, marine hazards, or seismic events. Potential effects of the environment on any project are a function of project or infrastructure design in the context of its receiving environment. These effects may act on the Project resulting in adverse changes to Project components, schedule, and/or costs.

In general, environmental conditions that can affect construction of the Project, infrastructure, or operational performance will be addressed through engineering design and industry standards. Good engineering design involves the consideration of environmental effects and loadings or stresses from the environment on a project.

As a matter of generally accepted engineering practice, designs and design criteria tend to consistently overestimate and account for possible forces of the environment. Engineering design therefore inherently incorporates a considerable margin of safety so that a project is safe and reliable throughout its lifetime. The PEI Energy Corporation, MECL and NB Power will also monitor any observed effects of the environment on the Project, and take action, as necessary, to repair and upgrade Project infrastructure and modify operations to permit the continued safe operation of the facility.

4.1 SCOPE OF ASSESSMENT

Potential effects of the environment on the Project relevant to conditions potentially found in Northumberland Strait and considered in this assessment are:

- climate, including weather and weather variables such as:
  - air temperature and precipitation
  - fog and visibility
  - winds
  - extreme weather events
  - storm surges and waves
- climate change (including sea-level rise and coastal erosion)
- sea ice
- seismic events

4.1.1 Regulatory and Policy Setting

Direction on the scoping of effects of the Environment on the Project for this assessment have been provided by PEI and NB governments, as noted in the following section.

4.1.2 The Influence of Consultation and Engagement on the Assessment

As outlined in Volume 1, Section 3.2 (Consultation and Engagement), scoping documents were sent to provincial regulators in PEI and New Brunswick, in addition to PWGSC.

Two comments relevant to scoping of potential effects of the environment on the Project relevant to the Northumberland Strait were received from government representatives. PEIDCLE advised that *"all climate change adaptation impacts on the infrastructure"* (e.g., flooding, erosion, wind, freezing rain) be addressed in the assessment. The NBDELG Technical Review Committee has requested that future climate conditions be considered by the Proponent with respect to location, design and construction of the transmission line and its associated infrastructure.

First Nations engagement with MCPEI was held in April 2015. In July 2015 a letter was sent to MCPEI to provide an update to the environmental assessment process. A response from MCPEI was received on August 6, 2015; no concerns specifically related to the effects of the environment on the Project were expressed.

A letter describing the EIA process for the Project was sent to the Assembly of First Nations' Chiefs in NB Inc. on July 31, 2015. No concerns regarding potential effects of the environment on the Project have been received to date.

4.1.3 Potential Environmental Effects, Pathways and Measurable Parameters

Potential effects of the environmental on the Project may include:

- reduced visibility and inability to manoeuver construction and operation equipment
- delays in receipt of materials and/or supplies (e.g., construction materials) and/or in delivering products
- changes to the ability of workers to access the site (e.g., if waves due to high winds were to prevent access within the Strait)
- damage to infrastructure
- increased structural loading
- corrosion of exposed oxidizing metal surfaces and structures, perhaps weakening structures and potentially leading to malfunctions
- loss of electrical power resulting in potential loss of production

These and other changes to the Project by the environment are generally characterized as delays or damage to the Project processes, equipment, marine vessels and vehicles. As a result, the effects analysis for effects of the environment on the Project is focused on the following effects:

- change in Project schedule
- damage to infrastructure

Some effects, such as damage to infrastructure, can also result in consequential effects on the environment; these environmental effects are addressed as Accidents, Malfunctions and Unplanned Events in Chapter 5.

4.1.4 Boundaries

4.1.4.1 Spatial Boundaries

The spatial boundaries for the assessment of effects of the environment on the Project include all areas where Project-related activities are expected to occur. For the purpose of this assessment, the spatial boundaries for effects of the environment on the Project are limited to the PDA, which is the area of physical disturbance associated with the construction of the Project. This includes the footprint of both submarine cables including the separating distance (width of the PDA is 220 m in total).

Where consequential environmental effects are identified, they are considered within the boundaries of the specific zone of influence of those consequences. Accidental events that could arise as a result of effects of the environment (e.g., severe weather), such as vessel collisions, are addressed in Chapter 5.

4.1.4.2 Temporal Boundaries

The temporal boundaries for the assessment of Effects of the Environment on the Project include construction, operation and maintenance, and decommissioning and abandonment. Total construction time in the marine environment will take place over a 20 to 25 week period. Pre-trenching in water less than 12 m is scheduled to be conducted from May to early July 2016, while the remaining trenching and cable installation are scheduled to be installed in October and November 2016. Operation will begin following construction and is anticipated to continue for the life of the Project (approximately 40 years). Decommissioning and abandonment would take place following the useful service life of the Project and would be carried out in accordance with regulations in place at that time.

4.1.5 Residual Environmental Effects Description Criteria

A significant adverse residual effect of the environment on the Project is one that would result in:

- a substantial change of the Project schedule (e.g., a delay resulting in the construction period being extended by one season)
- a long-term interruption in service (e.g., interruption in power transmission activities such that electricity demands cannot be met)
- damage to Project infrastructure resulting in a significant environmental effect
- damage to the Project infrastructure resulting in a substantial increase in a health and safety risk to the public or business interruption
- damage to the Project infrastructure resulting in repairs that could not be technically or economically implemented

4.2 EXISTING CONDITIONS FOR EFFECTS OF THE ENVIRONMENT ON THE PROJECT

4.2.1 Climate

Climate is defined as the statistical average (mean and variability) of weather conditions over a substantial period of time (typically 30 years), accounting for the variability of weather during that period (Catto 2006). The relevant parameters used to characterize climate are most often surface variables such as temperature, precipitation, and wind, among others.

The current climate conditions are generally described by the most recent 30 year period (1981 to 2010; Government of Canada 2015a) for which the Government of Canada has developed statistical summaries, referred to as climate normals. The closest weather station to the Project with available historical data is in Summerside, PEI, located approximately 20 km north-west of the Project. Limited historic climate data are available for the Summerside station; therefore, data from the Charlottetown weather station, located approximately 60 km from Borden-Carleton, are also used to supplement information on regional conditions relevant to the Northumberland Strait.

4.2.1.1 Air Temperature and Precipitation

The average monthly temperature in Summerside has ranged between -7.7 °C (January) and 19.2 °C (July) (Table 4.1). Extreme maximum temperature was 33.3 °C (July 1963) and the extreme minimum temperature was -29.9 °C (January 1982).

Summerside averages 1,072.9 mm of precipitation per year, of which, approximately 809.1 mm fell as rain and 277.9 cm as snow. Extreme daily precipitation at Summerside ranged from 41.9 mm (February) to 111.8 mm (August). On average, there have been 6 days each year with rainfall greater than 25 mm, and snowfalls greater than 25 cm occur on average 1 day per year (Government of Canada 2015a).

4.2.1.2 Fog and Visibility

Fog is defined as a ground-level cloud. It consists of tiny water droplets suspended in the air and reduced visibility to less than 1 km (Environment Canada 2014a). "Days with fog" are days when fog occurs and horizontal visibility is less than 1 km (thick fog) and 10 km (fog) (Phillips 1990). Limited historical climate data for fog and visibility are available for the Summerside station; therefore, fog data from the Charlottetown weather station, located approximately 60 km from the Project, are presented to provide some indication of the magnitude of fog experienced in the region. The hours with the measured increase in hours of reduced visibility (< 1 km) is between December and April (Government of Canada 2015a) (Table 4.2). Days with fog in PEI are relatively low throughout the year, as the surrounding provinces act as a barrier from the southerly fog off the Bay of Fundy (Phillips 1990). The Charlottetown weather station has experienced, on average, 190.8 hours (7.95 days) per year when visibility is less than 1 km.

Table 4.1 Air Temperature and Precipitation Climate Normals, Summerside and Charlottetown (1981-2010)

Month	Temperature (°C)					Precipitation (mm)					Mean No. of Days with							
	Averages			Extreme		Rainfall (mm)	Snowfall (cm)	Precipitation (mm)	Extreme daily Rainfall (mm)(Year)	Extreme Daily Snowfall (mm)(Year)	Temperature (°C)				Snow (cm)		Rain (mm)	
	Max	Min	Avg	Max (Year)	Min (Year)						>=30*	>=20*	<=20	<=-30	>=10	>=25	>=10	>=25
JAN	-3.2	-12.1	-7.7	12.1 (1979)	-29.9 (1982)	25.2	78.5	96.2	56.6 (1979)	53.6 (1961)	0	0	2.7	0	2.1	0.44	0.69	0.13
FEB	-2.5	-11.2	-6.9	12.8 (1976)	-26.1 (1943)	24.9	53.4	74.9	74.4 (1953)	40.4 (1990)	0	0	2.3	0	1.7	0.19	0.88	0.19
MAR	1.1	-6.8	-2.9	15.6 (1945)	-23.9 (1950)	34.6	47.4	79.4	33.3 (1944)	40.9 (1957)	0	0	0.44	0	1.4	0.19	1.1	0.12
APR	6.9	-1	3	23.3 (1945)	-13.4 (1995)	61.3	22.2	84.2	87.6 (1962)	37.6 (1962)	0	0.33	0	0	0.44	0.06	1.9	0.25
MAY	14.2	4.9	9.5	32 (1977)	-5 (1972)	94.9	3.2	97.7	58.7 (1951)	13.4 (1985)	0	5	0	0	0.13	0	3.1	0.67
JUN	19.4	10	14.7	32.2 (1947)	0 (1947)	91.3	0	91.3	57.9 (1968)	0 (1942)	0.07	13.6	0	0	0	0	3.1	0.44
JUL	23.8	14.6	19.2	33.3 (1963)	6.7(1952)	74.1	0	74.1	71.4 (1979)	0 (1942)	0.33	25	0	0	0	0	2.1	0.67
AUG	22.9	14.3	18.6	33.3 (1944)	4.4 (1953)	92.7	0	92.7	111.8 (1948)	0 (1942)	0.43	24.1	0	0	0	0	2.9	1.1
SEP	18.2	10	14.1	31.7 (1942)	-0.1 (1980)	96.8	0	96.7	109.2 (1942)	0 (1942)	0.1	10.1	0	0	0	0	3.3	0.8
OCT	12.1	4.6	8.4	24.4 (1968)	-5.6(1944)	87	0.7	87.7	69.3 (1968)	20.3 (1974)	0	1.1	0	0	0	0	2.9	0.8
NOV	5.8	-0.7	2.6	21.2 (1982)	-13.3 (1978)	77.2	19.1	97.7	90.4 (1944)	27.2 (1968)	0	0.07	0	0	0.5	0.06	2.6	0.31
DEC	-0.1	-7.5	-3.8	15.6 (1950)	-25.6 (1943)	49.2	53.5	100.3	46 (1944)	44.2 (1963)	0	0	0.53	0	1.4	0.07	1.5	0.47
Annual	9.9	1.6	5.7	-	-	809.1	277.9	1072.9	-	-	0.93	79.3	5.9	0	7.6	1	26	6

Note: * Data taken from the Charlottetown weather station, as these data are not available for Summerside.
Source: Government of Canada 2015a, 2015b

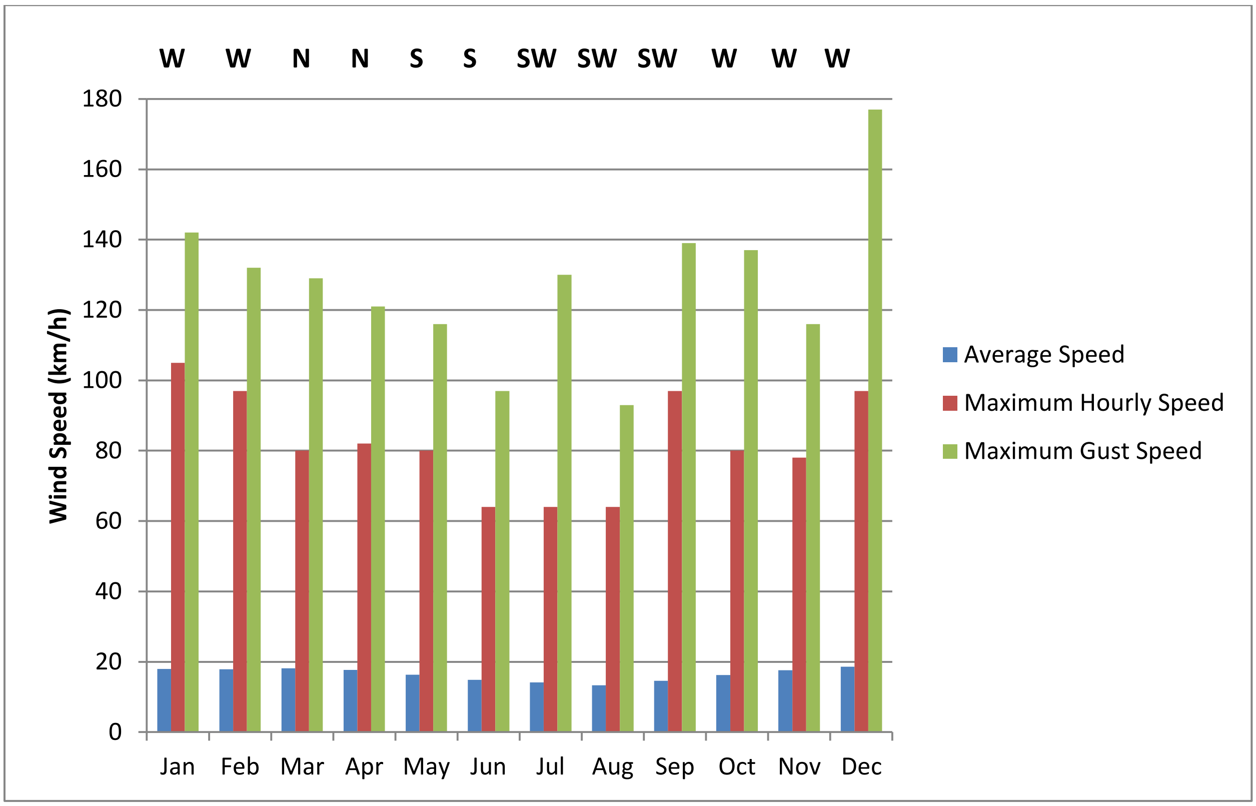
Table 4.2 Visibility - Climate Normals, Charlottetown (1981-2010)

	Visibility (hours with)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
< 1 km	29.4	25.1	28.4	25.4	17	10.9	5.7	4.5	4.2	2.8	11.4	26.1	190.8
1 to 9 km	136.6	117.6	116.5	107	90.1	80	69.2	73	56.3	58.1	91.6	135	1130.9
> 9 km	578	534.2	599.1	587.7	636.9	629.2	669.1	666.5	659.5	683.1	617	582.9	7443.1

Source: Government of Canada 2015b

4.2.1.3 Wind

Monthly average wind speeds measured at the Charlottetown weather station range from 13.3 to 18.6 km/h (Figure 4.1). From October to February, the dominant wind directions are from the west, with winds predominantly blowing from the north during March and April, from the south during May and June, and from the southwest during July to September (Government of Canada 2015b). Maximum hourly wind speeds measured at the Summerside weather station range from 64 km/h to 121 km/h, while maximum gusts for the same period range from 98 km/h to 145 km/h (Government of Canada 2015a). Occurrences of extreme winds are uncommon at Charlottetown; over the last three decades, there has been an average of 7.9 days per year with winds greater than or equal to 52 km/h and 1.8 days per year with winds greater than or equal to 63 km/h (Government of Canada 2015b).



Note: Monthly average wind speed and direction taken from Charlottetown data; Maximum hour and gust speed taken from Summerside data.

Figure 4.1 Predominant Monthly Wind Direction, Monthly Mean, Maximum Hourly and Maximum Gust Wind Speeds (1981 to 2010) at Summerside and Charlottetown, PEI

4.2.1.4 Extreme Weather Events

Extreme precipitation and storms can occur in the Northumberland Strait throughout the year, but tend to be more common and severe during the winter. Winter storms generally bring high winds and combination of snow and rain. More recently, extreme snowfall events in the winter of 2014/2015 affected much of PEI and New Brunswick. Some areas in PEI received as much as 551 cm of snow which broke the provincial record for the most snowfall recorded in one year (University of Prince Edward Island 2015). As a result, the Confederation Bridge was closed to traffic this winter more than most winters (CBC News 2015a). These winter conditions also delayed the ice melt in the Northumberland Strait, causing ferry services to postpone seasonal services and lobster and scallop fisheries to postpone the opening day for the fishery season (CBC News 2015b).

Thunderstorms during the early summer typically attenuate as they cross the Northumberland Strait, from New Brunswick, due to the cold waters of the Strait. As the summer progresses, however, water temperatures warm up and are able to sustain or strengthen thunderstorms as they travel across the Strait to PEI (NAV CANADA 2000).

4.2.1.5 Storm Surges and Waves

Rising sea levels and more frequent and severe weather events have brought about an increase in frequency of storm surges. Storm surges are defined as the elevation of water resulting from meteorological effects on sea level. During the past 15 years, storm surges have resulted in property destruction in all four Atlantic Provinces (Vasseur and Catto 2008). In Atlantic Canada, storm surges have been higher in coastal waters and highest in the Gulf of St. Lawrence (Bernier et al. 2006). A study from 1997 (Parkes et al. 1997) reported that storm surges in southeastern New Brunswick ranged from 0.6 m to 2 m in height and surges above 0.6 m in height occurred about two to three times per year along the Canadian Atlantic coast. Typically, surges were found to last for an average of 2.2 hours, and occasionally over 12 hours.

Run-up waves are produced from wind blowing over the surface of water. Maximum wave height is primarily a function of wind strength, wind duration and the length of exposed water (“fetch”). Substantial run-up waves usually occur during extreme storm events such as tropical cyclones and nor’easters.

4.2.2 Climate Change

While “climate” refers to average weather conditions over a 30-year period, “climate change” is an acknowledged change in climate that has been documented over two or more periods, each with a minimum duration of 30 years (Catto 2006). The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes, external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC 2012). The United Nations Framework Convention on Climate Change makes a distinction between climate change attributed to human activities and climate variability attributable to natural causes. Climate change is a change of climate directly or indirectly attributed to human activity that alters the composition of the global atmosphere, which is in addition to natural climate variability observed over comparable time periods (IPCC 2007a).

Predictions of effects of climate change are limited by the inherent uncertainty of climate models in predicting future changes in climate parameters. Global and regional climate models can provide useful information for predicting and preparing for global and macro-level changes in climate; however, the ability of models to pinpoint location-specific changes to climate is still relatively limited.

4.2.2.1 Sea Level Rise

Global sea levels have risen 1.8 mm/year over a 40 year period (1961 to 2003) and a more recent rate of 3.1 mm/year between 1993 and 2003 (Bindoff et al. 2007). The sea level has been slowly and steadily rising in most of Atlantic Canada for centuries due to crustal subsidence, warming trends, and the melting of polar ice caps (Government of Newfoundland and Labrador 2003). In particular, the sea level has been gradually rising along the southeastern coast of New Brunswick for a long time (several thousand years) and the changes associated with this rise have become especially evident along the Northumberland Strait over the last several decades (Daigle et al. 2006) due to the low coast profile and substantive development near the coast line and on lands near mean sea level. Most of Atlantic Canada is also experiencing some crustal subsidence in coastal areas, thus compounding the rise in sea level (Vasseur and Catto 2008).

Sea level rise sensitivity is defined as the degree to which a coastline may experience physical changes such as flooding, erosion, beach migration, and coastal dune destabilization (Natural Resources Canada 2010a).

Sea levels are expected to continue to rise at a greater rate in the 21st Century than was observed between 1961 and 2003 due to more rapid warming, which in turn increases rate of melting of the ice caps and glaciers. By the mid-2090s, global sea levels are projected to rise at a rate of approximately 4 mm/year, and reach 0.22 m to 0.44 m above 1990 levels (Bindoff et al. 2007). It is generally understood that a rise in sea level, coupled with more frequent and severe weather, are likely to bring about storm surges that could flood areas in Atlantic Canada that were once unlikely to flood (Conservation Corps of Newfoundland and Labrador 2008).

As the sea level continues to rise, the frequency of higher storm surges will increase (Vasseur and Catto 2008). At the current sea level, storm surges of 3.6 m are anticipated annually in the southern Gulf of St. Lawrence by 2100 (Parkes et al. 2006). Over the next 100 years storm surges in excess of 4.0 m are anticipated to occur once every 10 years (Vasseur and Catto 2008).

Climate systems are highly variable, reducing the certainty with which climate projections can be made. While the directions of some climate conditions are nearly certain, there is greater uncertainty in the projected magnitude or extent of the conditions. For example, while it is expected that temperatures will increase over the next 80 years, determining the extent of that temperature increase becomes progressively more difficult further into the future. When investing in infrastructure and industries of the future that will be subject to sea level rise and storm surges, precautions must be taken in their design to ensure adequate consideration of the effects of climate change.

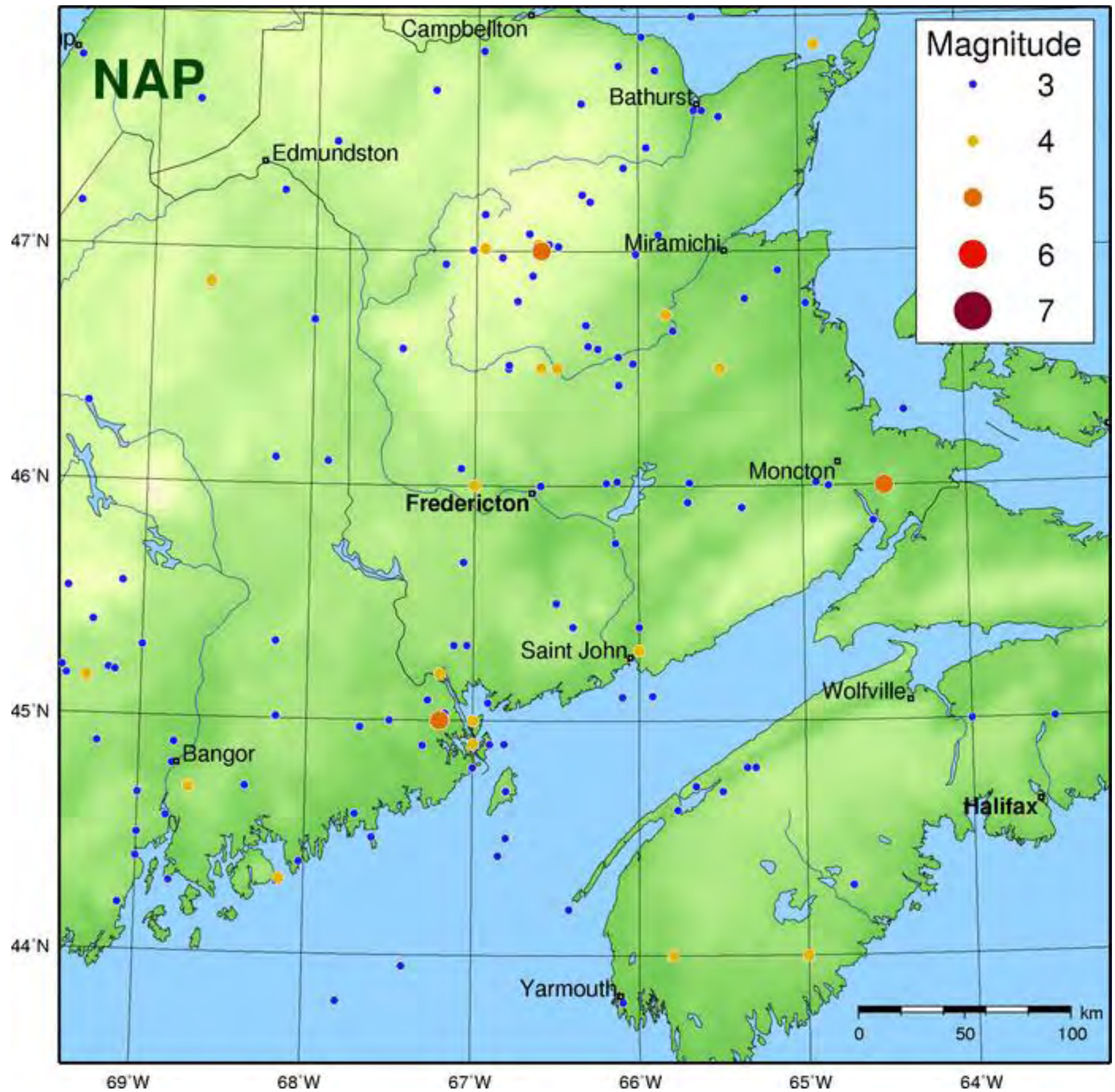
Sea-level rise is occurring in Nova Scotia, Prince Edward Island, and most of New Brunswick due to a rising sea and a sinking earth surface. Sea-level rise is most significant in areas with low-lying shorelines of estuaries, lagoons and coastal plains, and most sensitive to barrier islands, spits, and salt marshes (PEIDELJ 2011).

Coastal erosion caused by sea-level rise and wave action may also be influenced by the strength of the coastal material. The sedimentary rocks (i.e., sandstone and shale) and sand that is common in PEI is extremely vulnerable to erosion, due to the weak resistance of the material (PEIDELJ 2011). A coastal erosion assessment for both PEI and New Brunswick landing sites was conducted by Stantec in 2014. Refer to the Effects of the Environment on the Project VCs in Volumes 2 and 3, Sections 4.2.2.1 and 4.2.2.1, respectively, for methods and results of the assessment.

4.2.3 Seismic Activity

Seismic activity is dictated by the local geology of an area and the movement of tectonic plates comprising the Earth's crust. Natural Resources Canada monitors seismic activity throughout Canada and identifies areas of known seismic activity in order to document, record, and prepare for seismic events that may occur.

The Project lies within the Northern Appalachians seismic zone (Figure 4.2), one of five seismic zones in southeastern Canada (NRCan 2013). Figure 4.2 indicates that there was one seismic occurrence within the Northumberland Strait of a magnitude of 3. Natural Resources Canada (2013b) explains that it is very unlikely that an earthquake of magnitude less than 5 could cause damage. The level of historical seismic activity in this zone is low. Due to the low frequency and magnitude of seismic activity within the Strait, the likelihood of seismic activity occurring during the life of the Project is low and is therefore not assessed further.



Source: NRCan 2013

Figure 4.2 Northern Appalachians Seismic Zone

4.2.4 Sea Ice

During the last week of December, ice starts to form in the coastal areas of the Northumberland Strait. The Strait is typically completely covered in ice during the first week of January. Ice begins to melt in the third week of March and the Strait is typically ice-free late April (Obert and Brown 2011). In the Strait, there were 633 freezing degree days in 2008 and 580 freezing degree days in 2007 (IFN Engineering 2007, 2008). The ice thickness between those years was on average less than one meter (Brown 2007).

The Strait develops a range of ice floes and ice thicknesses throughout the winter months. In combination with the ice development and the wind and currents, ice ridges and rubble fields are created in the Strait during these months (Obert and Brown 2011).

Geophysical surveys were conducted in 2014 by the Canadian Seabed Research Ltd. over the proposed cable routes in the Northumberland Strait. These surveys were conducted in order to characterize the surficial and shallow sub-surface geology, and to identify potential submarine hazards to the cables. Ice scour surveys were conducted at both landfall sites using SSS and singlebeam bathymetry.

There were 133 ice scour events reported from the SSS data collected in 2014. Scour measurements were taken from unscoured, smoothed seabed datum to the deepest point of the scour. The ice scour events identified occurred in water depths from 2 to 13 m. Scour was most frequent in water depths of 4 to 5 m. Sediment transport within the Northumberland Strait highly influences scour degradation and the extent of infilling that occurs (CSR 2015).

As a result, navigation can be hindered due to thick ice formation in the Strait (Canadian Coast Guard 2013), and ice scouring could affect the submarine cables.

4.3 ASSESSMENT OF EFFECTS OF THE ENVIRONMENT ON THE PROJECT

4.3.1 Effects of Climate on the Project

4.3.1.1 Project Pathways for Effects of Climate on the Project

The potential effects of climate must be considered during infrastructure development, particularly in marine environments. Extreme temperatures and severe precipitation, fog and visibility, winds and extreme weather events could potentially cause:

- reduced visibility and inability to manoeuver equipment
- delays in construction/operation activities and delays in receipt of materials
- inability of personnel to access the site (e.g., if waves due to high winds were to prevent construction in the marine environment)
- damage to infrastructure
- increased structural loading

During construction, extreme low temperatures have the potential to reduce the ductility of construction materials used in Project components (e.g., ancillary facilities) and increase susceptibility to brittle fracture.

Snow and sea ice have the potential to increase loadings on Project infrastructure (e.g., ship decks of cable laying vessel and support vessels). Extreme snowfall and sea ice can also affect winter construction activities by causing a delay in construction or a delay in delivery of materials, and resulting in additional effort for clearing and removal. Construction activities will, however, only be occurring during the late spring/early summer and fall, and therefore, extreme snowfall during construction is not anticipated.

During operation or decommissioning and abandonment phases, the PDA could experience heavy rain, snowfall and freezing rain events that could delay project maintenance. Ice scour or sea bed movements could affect the integrity of marine cables.

Reduced visibility due to fog could make maneuvering of equipment (e.g., support vessels) difficult in the early part of the day. However, these short delays are anticipated and can often be predicted, and allowance for them will be included in the construction schedule. Disruption of construction activities and delays to the construction schedule will be avoided by scheduling tasks that require precise movements for periods when the weather conditions are favorable.

Wind storm events could potentially cause reduced visibility and interfere with maneuvering of equipment (e.g., support vessels) or transporting materials or staff movements (e.g., during cable laying or maintenance activities).

Coastal erosion as a result of sea level rise, storm surges and waves can affect land-based Project facilities located near the shoreline (e.g., cables at the landing site, termination site) if not properly accounted (e.g., shoreline protection).

4.3.1.2 Mitigation for Climate

To address the potential effects of climate (air temperature, precipitation, fog and visibility, winds, and extreme weather events), all aspects of Project, design, materials selection, planning, and maintenance will consider normal and extreme conditions that might be encountered throughout the life of the Project. In particular, construction and maintenance of marine infrastructure (i.e., cables), will be undertaken by specialized vessels and crews that are fully capable of working under normal and extreme weather conditions associated with the Northumberland Strait. Work will also be scheduled where feasible to avoid predicted times of extreme weather for the safety of crews and Project infrastructure.

The Project will be constructed to meet applicable building, safety and industry codes and standards. The engineering design of the Project will consider and incorporate potential future changes in the forces of nature that could affect its operation or integrity. For example, storm surges and waves will be considered in engineering of and design plans for the submarine cables. Project infrastructure will be built to meet the current and anticipated extreme future environmental loads. The Project components will be designed to meet CSA standards and other design codes and standards for wind, snowfall, extreme precipitation, and other weather variables associated with climate.

4.3.1.3 Residual Effects of Climate on the Project

The potential effects of climate on the Project during the construction, operation, and decommissioning and abandonment phases will be considered and incorporated in the planning and design of Project infrastructure and scheduling. This will be done to reduce the potential for Project delays and long-term damage to infrastructure and risk to workers, taking into account the existing and predicted climate conditions. Inspection and maintenance programs will prevent the deterioration of the infrastructure and will help to maintain compliance with applicable design criteria and reliability of the transmission system. Significant residual adverse effects of climate on the Project, or interruption to the Project schedule, are not anticipated.

4.3.2 Effects of Climate Change on the Project

4.3.2.1 Project Pathways for the Effects of Climate Change on the Project

Long term increases in temperature and precipitation as a result of climate change predicted for Atlantic Canada can result in changes to sea states and other conditions that could affect the long term integrity and reliability of Project-related marine infrastructure. The historical and projected extremes in temperature, intense precipitation, or other storm events must be accounted for in the design of the Project and in all other aspects of Project planning, construction and maintenance.

4.3.2.2 Climate Change Predictions

Predicting the future environmental effects of climate change for a specific area using global data sets is challenging due to generic data and larger scale model outputs that do not take into account local climate. Accurate regional and local projections require the development of specific regional and local climate variables and climate change scenarios (Lines et al. 2005). As a result, downscaling techniques have emerged over the last decade as an important advancement in climate modelling. Downscaling is used to introduce micro-scale interactions by including the local climate variables. Downscaling techniques are particularly important for Atlantic Canada due to the inherent variability associated with the predominantly coastal climate. Statistical downscaling uses global climate model (GCM) projections as well as historic data from weather stations across the region, and studies the relationship between these sets of data. Downscaling produces more detailed predictions for each of these weather stations (Lines et al. 2005) and has allowed for a better understanding of future climate scenarios based on precise and accurate historic data sets.

Results tend to differ between a Statistical Downscaling Model (SDSM) and Canadian Coupled General Circulation Model Version 2 (CGC^{M2}). The overall mean annual maximum temperature increase projected for Charlottetown (the nearest modelled location to the Project) between years 2020 and 2080 ranged from 1.70°C to 3.51°C for the SDSM model results and 1.16°C to 2.47°C for the CGCM2 model results (Lines et al. 2008) (Table 4.3).

Table 4.3 Projected Mean Annual Maximum and Minimum Temperature Change, and Precipitation Percent Change for both SDSM and CGCM2 Model Results

Period	T_{max}		T_{min}		% Precipitation	
	SDSM	CGCM2	SDSM	CGCM2	SDSM	CGCM2
2020s	1.70	1.16	1.69	1.77	13	0
2050s	2.46	1.67	2.33	2.40	16	5
2080s	3.51	2.47	3.34	3.36	18	4

Notes:
A positive value denotes an increase, a negative value denotes a decrease
SDSM = Statistical Downscaling Model
CGCM2 = Canadian Coupled General Circulation Model Version 2
T_{max} = Mean annual maximum temperature change
T_{min} = Mean annual minimum temperature change
Source: Lines et al. 2008

The SDSM projections for maximum temperature for 2050 at Charlottetown are increases for all seasons (1.7°C to 4.2°C) (Lines et al. 2005). By the year 2080, temperatures are projected to increase again in all seasons, with greater warming (3.7°C to 6.6°C) (Lines et al. 2005). This average temperature change is expected to be gradual over the period and is likely to affect precipitation types and patterns. The warmer fall and winter temperatures could mean later freeze up; wetter, heavier snow; more liquid precipitation occurring later into the fall; and possibly more freezing precipitation during both seasons. Changes to precipitation patterns due to warmer weather over the fall and winter months could lead to stronger spring run-off (Natural Resources Canada 2001).

There is less agreement among the global circulation and regional downscaling models regarding changes in precipitation. Annual precipitation increases projected for Atlantic Canada between the years 2020 and 2080 range from 18% to 21% for the SDSM model results, and -2% to 2% for the Canadian Coupled Global Climate Model Version 1 (CGCM1) model results (Lines et al. 2005). Precipitation trends are of more interest when taken together with the temperature increases and the seasonality of the predicted changes. Statistical Downscaling Model trends for the years 2020 to 2080 indicate a temperature increase of 8% to 12% for the winter months and 21% to 35% for the summer months (Lines et al. 2005). It is generally considered that the increased precipitation being projected for portions of western Atlantic Canada may be the result of continued landfall of dying hurricanes and tropical storms reaching into this area in the summer and fall months (Lines, G., Personal communication, March 5, 2006). While SDSM results highlight an increase in summer and fall precipitation, the CGCM1 results range from no change in the 2020s to a reduction in precipitation over the summer season for the years 2050 to 2080 (Lines et al. 2005).

The inconsistencies between SDSM and CGCM1 predicted seasonal precipitation changes highlight the inherent variability and uncertainty in climate modelling. Due to the increased precision of localized data used in SDSM relative to global modelling, confidence is considered to be greater in the SDSM results relative to global model results. Results must be interpreted with caution for each of the models although there is a general consensus in the climatological community concerning the overall anticipated environmental effects of climate change. For example, over the next 100 years, Atlantic Canada will likely experience warmer temperatures, more storm events, increasing storm intensity, and flooding (Vasseur and Catto 2008).

4.3.2.3 Mitigation for Climate Change

As discussed in Section 4.3.1.2, the Project will be designed according to engineering design practices that will consider predictions for climate and climate change. Several publications are available to guide design engineers in this regard, including, for example, the Public Infrastructure Engineering Vulnerability Committee (PIEVC) "Engineering Protocol for Infrastructure Vulnerability Assessment and Adaptation to a Changing Climate" (PIEVC 2011). This protocol outlines a process to assess the infrastructure component responses to changing climate, which assists engineers and proponents in effectively incorporating climate change into design, development and management of their existing and planned infrastructure. This and other guidance will be considered, as applicable, in advancing the design and construction of the Project.

4.3.2.4 Residual Effects of Climate Change on the Project

The potential effects of climate change on the Project will be considered and incorporated in the planning and design of Project infrastructure and scheduling. This will be done to reduce the potential for Project delays and long-term damage to infrastructure and risk to workers, taking into account predictions for climate change in the region. Inspection and maintenance programs will prevent the deterioration of the infrastructure and will help to maintain compliance with applicable design criteria and reliability of the transmission system. Significant residual adverse effects of climate change on the Project or system reliability are not anticipated.

4.3.3 Effects of Sea Ice on the Project

4.3.3.1 Project Pathways for the Effects of Sea Ice on the Project

The formation of ice ridges and rubble fields are common in the Northumberland Strait during the winter months.

As such, ice scour may be an issue for the submarine cables, and has been considered in the design of the submarine cables.

Sea ice presence is also an issue for construction and maintenance activities in the Northumberland Strait. Installation and maintenance of the submarine cables cannot occur during the ice season.

4.3.3.2 Mitigation for the Effects of Sea Ice on the Project

Ice scour protection is necessary for shallow, near-shore sections of cable (i.e., waters less than approximately 12 m depth). Protection will consist of cable burial beneath the influence of ice scour. The cable is to be buried at a trench depth of 2 m in sand and silt and only 1 m in areas of bedrock, extending from the foreshore to a water depth of 12 m. In areas where cable burial is not possible, concrete mats or similar protection methods will be used as protection against ice scour.

Sea ice will be avoided during construction and maintenance through scheduling. Installation of the submarine cables is scheduled to take place during the ice-free season. Similarly, regular maintenance of the submarine cables will be scheduled during periods when the Strait is free from ice. In the event of emergency repairs or maintenance required during the winter, specialized vessels and crews familiar with working in such conditions will be contracted.

4.3.3.3 Residual Effects of Sea Ice on the project

There is potential for marine cables to be exposed to sea ice during the life of the Project. However, the potential adverse effects on the Project during construction and maintenance activities have been considered in the planning and design of the Project including scheduling of cable installation, and properly mitigated such that substantive residual adverse effects of sea ice on the Project, or interruption to the Project schedule, are not anticipated.

4.4 DETERMINATION OF SIGNIFICANCE

The marine components of the Project will be designed, constructed and operated to maintain safety, integrity and reliability in full consideration of existing and reasonably predicted environmental forces in the PDA of the Northumberland Strait. There are no environmental attributes that, at any time during the Project, are anticipated 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 servicing such that production targets cannot be met)
- damage to Project infrastructure resulting in increased safety risk

PEI Energy Corporation, MECL and NB Power will use an adaptive management approach in its activities throughout the life of the Project to monitor any observed effects of the environment and adapt (e.g., repair/replace) the Project infrastructure or operations as needed. Accordingly, the effects of the environment on the Project are rated not significant.

5.0 ACCIDENTS, MALFUNCTIONS AND UNPLANNED EVENTS

This section provides an assessment of selected accident, malfunction, and unplanned event scenarios potentially associated with Project components and activities in the Northumberland Strait that could, if they occurred, result in adverse environmental effects.

5.1 APPROACH

In this section, the potential accidents, malfunctions, and unplanned events that could occur during any phase of the Project are described and assessed. The focus is on credible accidents that have a reasonable probability of occurrence, and for which the resulting environmental effects could be significant.

The general approach to assessment of the selected accident scenarios includes the following steps:

- consideration of the potential event that may occur during the life of the Project
- description of the safeguards established to protect against such occurrences
- consideration of the contingency or emergency response procedures applicable to the event
- determination of significance of potential residual adverse environmental effects

5.1.1 Significance Definition

Criteria used for determining the significance of adverse residual environmental effects with respect to accidents, malfunctions, and unplanned events relate to population and resource sustainability. Where applicable, definitions are the same as determined in the respective VC sections in this volume.

5.2 POTENTIAL INTERACTIONS

The accidents, malfunctions, and unplanned events scenarios considered in this assessment are detailed in Volume 1, Section 2.6.1. The scenarios considered applicable to the marine components of the Project (all phases) are:

- fire
- hazardous material spill
- vessel accident

VCs in this volume with reasonable potential to interact with these scenarios causing adverse environmental effects include (Table 5.1):

- Atmospheric Environment
- Marine Environment
- Commercial Fisheries
- Other Marine Users

- Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Table 5.1 Summary of Potential Interactions for Marine-Based Project Activities within and along the Northumberland Strait

Accident, Malfunction or Unplanned Event	Atmospheric Environment	Marine Environment	Commercial Fisheries	Other Marine Users	Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons
Fire	✓				
Hazardous Material Spill		✓	✓	✓	✓
Vessel Accident		✓	✓		✓

5.3 FIRE

5.3.1 Potential Event

There is potential that fire could involve a vessel or equipment used for construction or maintenance activities; other Project infrastructure is submerged. If fire were to occur, there is potential for an effect on the Atmospheric Environment.

5.3.2 Risk Management and Mitigation

The following mitigation measures should be applied in general to reduce the probability of a vessel fire and any associated adverse effects:

- Project-related marine vessels will be equipped with fire detection and suppression equipment in accordance with the *Transport Canada Fire Detection and Extinguishing Equipment Regulations* (2007) made under the *Canada Shipping Act* (2001).
- Project staff working on vessels will be trained in fire suppression.
- Vessel-to-vessel and vessel-to-land communication systems are expected to be in place and functioning.
- Vessel operators will be required to provide appropriate certification to operate including fire suppression plans.
- Vessel operators must adhere to applicable Acts and Regulations administered by or in conjunction with Transport Canada.

As the Project location within the Northumberland Strait is not considered remote, local emergency response services, including the Canadian Coast Guard, are available.

5.3.3 Potential Environmental Effects and their Significance

As the majority of the construction and maintenance equipment within the Marine Environment will be submerged, the primary risk of fire is on-board a support vessel. A fire on-board a vessel could potentially affect workers and members of the public in close proximity, damage Project infrastructure, and result in emissions to the Atmospheric Environment. It is expected that fire, if it were to occur, would be small and easily extinguished using on-board fire suppression systems, resulting in minimal smoke generation and subsequent effects on the Atmospheric Environment.

In consideration of the mitigation and response measures to be undertaken to prevent and respond to a fire, residual adverse environmental effects of a marine-based fire are rated as not significant for potentially affected VCs.

5.4 HAZARDOUS MATERIAL SPILL

5.4.1 Potential Event

Hazardous material spills can occur in any environment where fuels, lubricants, hydraulic fluid, paints, or corrosion and fouling inhibitors are used or stored. Hazardous materials required for Project components and activities in the Northumberland Strait are most likely associated with vessel fuel and hydraulic equipment used during construction, and operation and maintenance of the marine cables. As the new marine cables are solid-state design, no lubricant is present in the cable. Therefore, rupture of the cable during construction, and operation and maintenance does not pose a risk for a hazardous material spill into the Marine Environment.

The worst case for a marine-based hazardous material spill would likely be a rupture of a hydraulic line associated with trenching equipment or the loss of fuel from a vessel grounding or collision.

5.4.2 Risk Management and Mitigation

A Project-specific Emergency Response Plan (ERP) will be developed and will include procedures to prevent and respond to a spill into the marine environment. These procedures will include:

- routine preventative maintenance and inspection of hydraulic equipment is to be undertaken to avoid a hazardous material release from submerged equipment
- hazardous materials will not be stored on vessels in large quantities and vessels will not be fueled at sea (if possible)
- relevant Project staff will be trained in the timely and efficient response to hazardous material spills
- vessels are to be equipped with appropriately sized spill kits equipped to handle the quantity and type(s) of hazardous materials that may be onboard the vessel
- vessel-to-vessel and vessel-to-land communication systems are expected to be in place and functioning
- any spill will be reported to Coast Guard Emergency Response

- vessel operators must adhere to applicable Acts and Regulations administered by or in conjunction with Transport Canada

Any accidental release of material onboard a vessel should be mitigated before it has the potential to reach the marine environment. Spill containment and remediation will be required immediately if a release occurs in the marine environment.

5.4.3 Potential Environmental Effects and their Significance

As Project work takes place in the Northumberland Strait, accidental releases of hazardous materials have the potential to affect components of the Marine Environment, Commercial Fisheries, Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons, and Other Marine Uses. This is most likely through harm to or mortality of marine species caused by a hazardous material and a potential disruption to fisheries and recreational water use until clean-up efforts are completed. A release due to a vessel accident or malfunction of submerged equipment would most likely be a small quantity due to the limited amount of hydraulic fluid and fuel.

In consideration of volumes of hazardous materials potentially used during the Project, the mitigation and response measures to be undertaken to prevent and respond to accidental releases of hazardous materials, residual adverse environmental effects of a marine-based hazardous material spill are rated as not significant for potentially affected VCs. Although unlikely, if a large spill of hazardous materials occurred, it could potentially result in change in distribution or decline in abundance of marine populations, and result in a significant residual adverse environmental effect.

5.5 VESSEL ACCIDENT

5.5.1 Potential Event

During Project construction and, to a lesser extent, during operation and maintenance of the Project, a number of marine vessels will be in motion along the Project route. There is potential for vessel-to-vessel and vessel-to-wildlife collisions. Potential collisions with wildlife include collisions of marine mammals, and sea turtles with the underside of a vessel, or the collision of a bird with a vessel due to attraction to vessel lighting.

These consequences may have an effect on Marine Environment, Commercial Fisheries and the Current Use of Resources for Traditional Purposes by Aboriginal Persons.

The worst case scenario for a vessel collision would be the loss of human life, followed by loss of a *SARA*-listed species which could potentially lead to population-level effects. There is also potential for vessel-based fire and release of hazardous materials (fuel). These are addressed in previous sections.

5.5.2 Risk Management and Mitigation

The following mitigation measures should be applied in general to reduce the probability of a vessel-to-vessel collision or vessel interaction with marine wildlife and any associated adverse effects:

- deck lighting will be minimized whenever it is safe and practical to do so and the use of unnecessary lighting will be avoided, to reduce the risk of attracting marine wildlife
- due to the nature of the work submarine cable vessels will move slowly. Support vessels will operate at reduced speeds when possible, to reduce the risk of vessel-to-vessel collision and vessel collisions with marine wildlife
- safety zones will be identified around work areas
- high speed vessel maneuvers are not to be conducted by any Project vessel during marine-based Project activities
- vessel-to-vessel and vessel-to-land communication systems are expected to be in place and functioning
- vessel operators must adhere to applicable Acts and Regulations administered by or in conjunction with Transport Canada, including the Transport Canada Collision Regulations (2014).

Vessels involved in the Project must abide by the guidelines, restrictions and navigation channels within the Guidelines for Navigation Under the Confederation Bridge (Transport Canada 2009) and Northumberland Strait Traffic. As the central navigation channel of the Confederation Bridge is a compulsory pilotage area, ships navigating the channel must have a licensed pilot on board. Vessels over 20 m in length are required to maintain contact on marine VHF Channel 12 (Vessel Traffic Regulating) and Channel 16 (Distress, Safety and Calling of Marine Vessels).

5.5.3 Potential Environmental Effects and their Significance

Vessel collisions, either with other vessels or marine wildlife, have the potential to affect components of the Marine Environment, Commercial Fisheries, the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons, and Other Marine Uses. This is most likely through vessel damage or harm to or mortality to humans or marine wildlife species, especially SARA-listed species.

As construction and maintenance activities will be limited in duration, the probability of an encounter with a bird species is low. Due to the dispersed nature of marine mammal and turtle populations, the short duration of the construction phase and the limited number and slow speeds of vessels involved, a ship strike involving a marine species is considered a low probability. If a wildlife encounter were to occur, it is not expected to result in population level changes.

In consideration of the mitigation and response measures to be undertaken to prevent and respond to vessel collisions, residual adverse environmental effects of a vessel collision are rated as not significant for potentially affected VCs.

5.6 DETERMINATION OF SIGNIFICANCE

MECL is developing emergency response plans to prevent and efficiently respond to accidental or unplanned events.

Although unlikely, if a large spill of hazardous materials occurred, it could potentially result in a change in distribution or decline in abundance of marine populations, and result in a significant residual adverse environmental effect. However, given the overall nature of the Project and credible Accidents, Malfunctions, and Unplanned Events considered, and in light of the nature of the Project and proposed mitigation and emergency response planning, the residual adverse environmental effects of Project-related Accidents, Malfunctions, and Unplanned Events on all VCs during all phases are rated not significant with a high level of confidence.

6.0 CUMULATIVE ENVIRONMENTAL EFFECTS: NORTHUMBERLAND STRAIT

6.1 INTRODUCTION

The residual effects of the Project that may interact cumulatively with the residual environmental effects of other physical activities are identified in this section and the resulting cumulative environmental effects are assessed.

An assessment of cumulative environmental effects is required if:

- the Project is assessed as having residual environmental effects on the VC
- the residual effects could act cumulatively with residual effects of other past, present, or reasonably foreseeable future physical activities

Three categories of physical activities in the Northumberland Strait have been identified as having the potential to result in residual environmental effects that may act cumulatively with those of the Project:

- commercial fishing
- recreation
- vessel traffic

In the Northumberland Strait, 4 VCs are anticipated to have residual effects. Interactions between the Project and the remaining 7 VCs are not anticipated to result in residual effects and an assessment of cumulative environmental effects is therefore not undertaken. An assessment of cumulative environmental effects is provided for the following VCs:

- Marine Environment
- Commercial, Recreational and Aboriginal Fisheries
- Heritage Resources
- Current Use of Land and Resources for Traditional Purposes

Table 6.1 below highlights the potential for interactions between the residual environmental effects of the Project and those of the physical activities identified. These interactions are described in further detail below.

Table 6.1 Potential Cumulative Environmental Effects

Other Physical Activities with Potential for Cumulative Environmental Effects	Marine Environment	Commercial Fisheries	Heritage Resources	Current Use of Land and Resources
Commercial Fishing	✓	✓		
Recreation	✓			
Vessel Traffic	✓	✓		

6.2 ASSESSMENT OF CUMULATIVE EFFECTS: NORTHUMBERLAND STRAIT

Past and existing physical activities that have been or are being carried out have influenced the baseline conditions for the assessment of Project effects. The effects of other physical activities that have been or are being carried out in combination with the effects of the Project are therefore considered in the assessment of the residual environmental effects of the Project.

Environmental effects on Heritage Resources may occur with any project or activity that involves ground disturbance. However, none of the activities listed in Table 6.1 involve ground disturbance and therefore do not have the potential to interact with Heritage Resources. As such, cumulative environmental effects on Heritage Resources are not predicted.

Commercial fishing, recreational activity and vessel operation will not result in increased disruption to access of areas used for Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons. Therefore, cumulative environmental effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal People are not anticipated.

The residual effects of the Project on the marine environment have the potential to interact cumulatively with the environmental effects of commercial fishing activities. However, residual effects of the Project on the marine environment are limited to the physical area of disturbance, during the construction phase only. As this is a short period of time, and a relatively small geographic area, cumulative environmental effects are not expected to be substantive.

Recreational activities may result in changes to marine populations through either direct or indirect disturbance. The magnitude and extent of any such changes (*e.g.,* to fish populations through recreational harvesting) is expected to be very small, and interactions with the residual environmental effects of the Project on the marine environment would not be substantive.

Vessel traffic within the RAA may interact with the marine environment by increasing underwater sound levels, and increasing the potential for direct mortality to fish and wildlife through collisions. Future vessel traffic is not expected to be notably higher than current levels, so cumulative effects to the marine environment would be similar to the residual environmental effects of the Project, which consider existing vessel traffic. Accordingly, cumulative environmental effects of the Project in combination with vessel traffic are not expected to be substantive.

The residual environmental effects of the Project on Commercial, Recreational and Aboriginal Fisheries have the potential to interact with the environmental effects of commercial fishing activities and vessel traffic. The temporary loss of access to fishing grounds as a result of the Project will be limited to the area of physical disturbance of the Project, and Project activities will be schedule outside of commercial fishing seasons to the extent possible. As the PDA is relatively small, and Project activities will be scheduled outside of commercial fishing seasons to the extent possible, cumulative effects on Commercial, Recreational and Aboriginal Fisheries will not be substantive. The temporary loss of access to fishing grounds is not anticipated from recreational activities and therefore no cumulative environmental effects with the environmental effects of these activities are anticipated. Accordingly, cumulative environmental effects of the environmental effects of the Project in the Northumberland Straight with the environmental effects of other physical activities are rated not significant.

7.0 SUMMARY

In this EIS, Stantec conducted an EIA of the PEI-NB Cable Interconnection Upgrade Project (the "Project") proposed by PEI Energy Corporation (PEIEC). The Project involves the construction and operation of a high voltage alternating current transmission system, spanning three geographic locations – New Brunswick, the Northumberland Strait and PEI. This volume includes an assessment of potential environmental effects associated with marine-based Project components and activities conducted in the Northumberland Strait.

7.1 SCOPE OF THE EIA

An EIA of the marine-based Project components and activities in the Northumberland Strait is required under Section 67 of *CEAA*. This EIS follows Stantec EA method that has been adapted to meet the requirements of both federal and provincial environmental assessments.

The EIA evaluated the potential environmental effects of the Project. The scope of the assessment included all activities necessary for the construction and operation of the Project (including presence of the infrastructure), but excluded the end uses of this electricity. Environmental effects were assessed for each phase of the Project (i.e., construction, operation, and decommissioning and abandonment), where relevant, as well as for credible Accidents, Malfunctions, and Unplanned Events. The assessment was conducted within defined spatial and temporal boundaries and in consideration of defined residual environmental effects rating criteria. The EIA considered measures that are technically and economically feasible that would mitigate any significant adverse environmental effects of the Project.

7.2 ENVIRONMENTAL EFFECTS ASSESSMENT

Marine Environment, CRA Fisheries, Heritage Resources, and Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons were identified for detailed assessment. These were identified by the study Team (based on experience and professional judgment) as the key VCs for which substantive interactions with the Project were anticipated or could occur. A separate analysis of the potential Effects of the Environment on the Project was also conducted.

The assessment concluded that the potential environmental effects of the Project in the Northumberland Strait for each of the VCs would be not significant during each phase of the Project. These conclusions were reached in consideration of the nature of the Project, the nature and extent of its environmental effects and the planned implementation of proven and effective mitigation. The environmental effects of Accidents, Malfunctions, and Unplanned Events were also rated not significant. Effects of the Environment on the Project were rated not significant due to design consideration and compliance with codes and standards that will mitigate against a significant adverse effect on the Project. The environmental effects and significance predictions were made with a high level of confidence by the study team.

7.3 OVERALL CONCLUSION

Based on the results of the EA for the Northumberland Strait, it is concluded that, with planned mitigation, the residual environmental effects of the Project during each phase is rated not significant.

8.0 REFERENCES

Environmental Setting

AMEC Earth and Environmental (2007). Northumberland Strait Ecosystem Overview Report. Prepared For Fisheries and Oceans by AMEC Earth and Environmental, Moncton, New Brunswick.

Historica Canada. 2015. Northumberland Strait. Available online at: http://www.thecanadianencyclopedia.ca/en/article/northumberland-strait/. Last Accessed on July 15, 2015.

Jacques Whitford Environment Limited (JWEL) (2001). Atlas of Ecology and Commercially Important Areas in the Southern Gulf of St. Lawrence. Environmental Studies Research Funds Report (ESRF)140, Calgary. 76p.

Atmospheric Environment

Environment Canada. 2015. Marine Weather forecasts available at: https://weather.gc.ca/marine/region_e.html?mapID=15, Last accessed on July 7, 2015

Other Marine Users

NorST-EMP. n. d. Northumberland Strait – Environmental Monitoring Partnership. Available at http://www.cwn-rce.ca/initiatives/canadian-watershed-research-consortium/northumberland-strait-environmental-monitoring-partnership-norst-emp/. Last accessed July 16, 2015.

Marine Environment

Abgrall, M.-J., S. Bastien-Daigle, G. Miron and M. Ouellette. 2010. Potential interactions between populations of Softshell Clams (*Mya arenaria*) and Eastern Oysters (*Crassostrea virginica*) in temperate estuaries, a literature review. Can. Tech. Rep. Fish. Aquat. Sci., 2892: vii + 88 pp.

AMEC Earth and Environmental. 2007. Northumberland Strait Ecosystem Overview Report. Prepared by AMEC Earth and Environmental for Fisheries and Oceans Canada, Moncton, NB. 252 pp.

Au, D.W.T., C.A. Pollino, R.S.S. Wu, P.K.S. Shin, S.T.F. Lau, and J.Y.M. Tang. 2004. Chronic effects of suspended solids on gill structure, osoregulation, growth, and triiodothyronine in juvenile green grouper Epinephelus coioides. Mar. Ecol. Prog. Ser. 266: 255-264.

Bajzak, C.E., M.O. Hammill, G.B. Stenson and S. Prinsberg. 2011. Drifting away: Implications of change in ice conditions for a pack-ice-breeding phocid, the harp seal (*Phoca goenlandica*). Can. J. Zool., 89: 1050-1062.

BERR (Department for Business Enterprise and Regulatoy Reform). 2008. Review of Cabling techniques and environmental effect applicable to the offshore wind farm industry. Technical Report: 164 pp.

Birds Studies Canada and Nature Canada. 2015. Important Bird Areas Canada. Available online at: http://www.ibacanada.ca/mapviewer.jsp?lang=en. Last accessed July 3, 2015.

Boulcott, P., Millar, C. P. and Fryer, R. J. 2014. Impact of scallop dredging on benthic epifauna in a mixed-substrate habitat. ICES Journal of Marine Science: 71(4), 834-844 pp.

Bourne, W. R. P. 1979. Birds and gas flares. Marine Pollution Bulletin, 10(5), 124-125.

Cargnelli, L.M., S.J. Griesbach, D.B. Packer and E. Weissberger. 1999. Essential Fish Habitat Source Document: Atlantic Surfclam, Spisula solidissima, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-142: v + 13 pp.

Castellote, M., C.W. Clark and M.O. Lammers. 2012. Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. Biological Conservation 147:115-122.

CH2M HILL. 2000. Appendix A: Suspended Sediment Effects on Fish – A Literature Review. 13 pp.

Chassé, J., N. Lambert, M. Comeau, P.S. Galbraith, P. Larouche and R.G. Pettipas. 2014. Environmental Conditions in the Southern Gulf of St. Lawrence Relevant to Lobster. DFO Can. Sci. Advis. Sec. Res. Doc., 2014/031: v + 25 pp.

Christian, J.R., C.G.J. Grant, J.D. Meade and L.D. Noble. 2010. Habitat requirements and life history characteristics of selected marine invertebrate species occurring in the Newfoundland and Labrador Region. Can. Manuscr. Rep. Fish. Aquat. Sci., 2925: vi + 207 pp.

Comeau, L.A., F. Pernet, R. Tremblay, S.S. Bates and A. LeBlanc. 2008. Comparison of eastern oyster (*Crassostrea virginica*) and blue mussel (*Mytilus edulis*) filtration rates at low temperatures. Can. Tech. Rep. Fish. Aquat. Sci., 2810: vii + 17 pp.

Constantino, R., M.B. Gaspar, J. tata-Regala, S. Carvallo, J. Cúrdia, T. Drago, R. Taborda and C.C. Monteiro. 2009. Clam dredging effects and subsequent recovery of benthic communities at different depth ranges. Mar. Enviro. Res., 67: 89-99.

Cornell Lab of Ornithology. 2014. All About Birds. Available online at: www.allaboutbirds.org.

CSR (Canadian Seabed Research). 2015. Northumberland Strait Cable Route Assessment, 2014 Marine Geophysical Survey. Prepared for Maritime Electric Company, Charlottetown, Prince Edward Island. CSR Project Number 1401.

Currie, D. R. and Parry, G. D. 1996. Effects of scallop dredging on a soft sediment community: a large-scale experimental study. Marine Ecology Progress Series: Vol. 134, 131-150 pp.

Davidson, L.-A., M. Biron and M. Niles. 2012. Scallop fishery assessment of the southern Gulf of St. Lawrence in 2010: Commercial fishery data. DFO Can. Sci. Advis. Sec. Res. Doc., 2012/007. vi + 40 pp.

DFO (Fisheries and Oceans Canada). 1993. Underwater World: Soft Shell Clam. Communications Directorate, Fisheries and Oceans Canada, Ottawa, ON. 6 pp.

DFO. 2010b. Aquatic Species - Details for American Oyster. Available online at: http://www.dfo-mpo.gc.ca/species-especes/aquatic-aquatique/american-oyster-huitre-eng.htm. Last accessed June 25, 2015.

DFO. 1996a. Scotian Shelf Atlantic Surf Clam. DFO Atl. Fish. Stock Status Rep., 96/122E: 2 pp.

DFO. 1996b. Southern Gulf soft shell clam. DFO Atl. Fish. Stock Status Rep., 96/101E: 3 pp.

DFO. 2001. Integrated Management Plan Clam Fishery Eastern New Brunswick Area Gulf Region, 2001-2006. viii + 56 pp. Available online at: http://www.dfo-mpo.gc.ca/Library/258964.pdf. Last accessed July 5, 2015.

DFO. 2003a. Profile of the Blue Mussel (*Mytilus edulis*), Gulf Region. Policy and Economics Branch, Gulf Region, Fisheries and Oceans Canada, Moncton, NB. viii + 36 pp. + Appendices.

DFO. 2003b. Profile of the Eastern Oysters (*Crassostrea virginica*), Gulf Region. Policy and Economics Branch, Gulf Region, Fisheries and Oceans Canada, Moncton, NB. ix + 34 pp. + Appendices.

DFO. 2005. The Gulf of St. Lawrence, A Unique Ecosystem: The Stage for the Gulf of St. Lawrence Integrated Management (GOSLIM). Oceans and Science branch, DFO. 30 pp. Available online at: http://www.dfo-mpo.gc.ca/library/318989e.pdf. Last accessed June 28, 2015.

DFO. 2007. Ecologically and Biologically Significant Areas (EBSA) in the Estuary and Gulf of St. Lawrence: Identification and characterization. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/016.

DFO. 2008. Aquatic Species at Risk – Harbour Porpoise (Northwest Atlantic Population). Available online at: http://www.dfo-mpo.gc.ca/species-especes/species-especes/harbourporpoiseAtl-marsouinat-eng.htm. Last accessed June 27, 2015.

DFO. 2009a. Underwater World: North American Lobster. Available online at: http://www.dfo-mpo.gc.ca/science/publications/uww-msm/articles/americanlobster-homarddamerique-eng.html. Last accessed June 24, 2015.

DFO. 2009b. Assessment of Cod in the Southern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2009/007: 15 pp.

DFO. 2009c. Underwater World: Atlantic Halibut - Estuary and Gulf of St. Lawrence (Canadian East Coast). Available online at: http://www.dfo-mpo.gc.ca/science/publications/uww-msm/articles/atlantichalibut-fletanatlantique-eng.html. Last accessed June 24, 2015.

DFO. 2009d. Underwater World: American Oyster - North American Atlantic Coast. Available online at: http://www.dfo-mpo.gc.ca/Science/publications/uww-msm/articles/americanoyster-huitreamericaine-eng.html. Last accessed June 24, 2015.

DFO. 2010a. Aquatic Species - Details for Surf Clam. Available online at: http://www.dfo-mpo.gc.ca/species-especes/aquatic-aquatique/surf-clam-mactre-amerique-eng.htm. Last accessed June 25, 2015.

DFO. 2011. Assessment of the scallop fishery (*Placopecten magellanicus*) of the southern gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2011/039: 17 pp.

DFO. 2011. Using satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2012/036: 13 pp.

DFO. 2012. Ice Navigation in Canadian Waters. Cat. No. Fs154-31/2012E-PDF. ISBN 978-1-100-20610-3. Ottawa, ON.

DFO. 2012a. Atlantic Cod in the Northern and Southern Gulf of St. Lawrence. Available online at: http://www.dfo-mpo.gc.ca/decisions/fm-2012-gp/atl-028-eng.htm. Last accessed on June 27, 2015

DFO. 2012b. Assessment of the Atlantic mackerel stock for the Northwest Atlantic (Subareas 3 and 4) in 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2012/031: 17 pp.

DFO. 2013. Aquatic Species at Risk – Fin Whale (Atlantic). Available online at: http://www.dfo-mpo.gc.ca/species-especes/species-especes/finwhale-atlantic-rorqual-commun-atlantique-eng.htm. Last accessed July 3, 2015.

DFO. 2013a. American lobster, *Homarus americanus*, stock status in the southern Gulf of St. Lawrence: LFA 23, 24, 25, 26a and 26b. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2013/029: 21 pp.

DFO. 2013b. Assessment of the Rock Crab (*Cancer irroratus*) fishery in the southern Gulf of St. Lawrence for 2006 to 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2013/030: 17 pp.

DFO. 2014. Assessment of Atlantic herring in the southern Gulf of St. Lawrence (NAFO Div. 4T) to 2013. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2014/040: 20 pp.

DFO. 2015. Seal Species. Available online at: http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/facts-faits/facts-faitsa-eng.htm#grey. Last accessed June 28, 2015

DFO. 2015. Stock Assessment of Atlantic Halibut of the Gulf of St. Lawrence (NAFO Divisions 4RST) for 2013 and 2014. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2015/023: 15 pp.

Dufour, R. and P. Ouellet. 2007. Estuary and Gulf of St. Lawrence marine ecosystem overview and assessment report. Can. Tech. Rep. Fish. Aquat. Sci., 2744E: vii + 112 pp.

Dutil, J.-D., S. Proulx, P. S. Galbraith, J. Chassé, N. Lambert and C. Laurian. 2012. Coastal and epipelagic habitats of the estuary and Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci., 3009: ix + 87 pp

ECL (Envirosphere Consultants Limited). 2003. Environmental Monitoring at the Black Point Ocean Disposal Site: Assessing Long-term Impacts of Dredge Spoil Disposal in Saint John Harbour, New Brunswick. Report for Environment Canada, Atlantic Region, Dartmouth, NS. 90 pp.

Environment Canada. 2009. Status of Birds in Canada. Available online at: http://www.ec.gc.ca/soc-sbc/oiseau-bird-eng.aspx?sL=e&sY=2011&sB=RBGU&sM=a. Last accessed June 29, 2015.

Erickson, W.P., G.D. Johnson, D.P. Jr. Young. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions. In: Ralph, C. John; Rich, Terrell D., editors 2005. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. 2002 March 20-24; Asilomar, California, Volume 2 Gen. Tech. Rep. PSW-GTR-191. Albany, CA: U.S. Dept. of Agriculture, Forest Service, Pacific Southwest Research Station: p. 1029-1042.

Fader, G.B.J. and S.S. Pecore. 1989. Surficial Geology of the Abegweit Passage Area of Northumberland Strait, Gulf of St. Lawrence. Geological Survey of Canada Open File #2087, 5 pp. and 6 maps.

Feist, B.E., J.J. Anderson and R. Miyamoto. 1996. Potential Impacts of Pile Driving on Juvenile Pink (Onchorhynchus gorbuscha) and Chum (O. keta) Salmon Behavior and Distribution. Fisheries Research Institute, School of Fisheries, University of Washington. Seattle, WA. viii+58 pp pp

Fisher C., M.Slater. Electromagnetic Field Study: Effects of Electromagnetic fields on marine species: A literature review. Oregon Wave Energy Trust. 2010.

Fuentes-Yaco, C., A.F. Vézina, T. Platt, W.G. Harrison, P.G. Connier, L.E. Waite, and L. Devine. 1998. Spatio-temporal distribution of phytoplankton pigments in Northumberland Strait: CZCS imagery and in situ data. Can. Tech. Rep. Hydrogr. Ocean Sci., 195: vii + 30 pp.

Gilkinson, K.D., G B.J. Fader, D.C. Gordon, Jr., R. Charron, D. McKeown, D. Roddick, E.L R. Kenchington, K. MacIsaac, C. Bourbonnais, P. Vass and Q. Liu. 2003. Immediate and longer-term impacts of hydraulic clam dredging on an offshore sandy seabed: Effects on physical habitat and process of recovery. Cont. Shelf Res., 23: 1315-1336.

Gill, A.B., Y.Huang, J. Spencer, I. Gloyne-Philips. Electromagnetic Fields emitted by High Voltage Alternating Current Offshore Wind Power Cables and interactions with marine organisms. 2008.

GNB (Government of New Brunswick). 2002. New Brunswick Wetlands Conservation Policy. Prepared by the New Brunswick Departments of Natural Resources and Energy and Environment and Local Government. 14 pp.

Gosner, K.L. 1978. A Field Guide to the Atlantic Seashore. The Peterson Filed Guide Series published by Houghton Mifflin Company, Boston, MA. xvi + 329 pp.

Hammill, M.O., G.B. Stenson and R.A. Myers. 2011. Hooded seal (*Cystophora cristata*) pup production In the Gulf of St. Lawrence. Can. J. Fish. Aquat., 49: 2546-2550.

Hammill, M.O., V. Lesage, Y. Dubé and L.N. Measures. 2001. Oil and Gas Exploration in the Southern Gulf of St. Lawrence: A Review of Information on Pinnipeds and Cetaceans in the Area. DFO Can. Sci. Advis. Sec. Res. Doc., 2001/115: 39 pp.

Hanson, J.M. 2009 Predator-prey interactions of American lobster (*Homarus americanus*) in the southern Gulf of St. Lawrence, Canada. New Zealand J. Mar. Fresh. Res., , 43:1, 69-88, DOI: 10.1080/00288330909509983

Hastings, M.C. and A.N. Popper. 2005. Effects of sound on fish. Report for the California Department of Transportation. Sacramento, CA.

Hauton, C., R.J.A. Atkinson and P.G. More. 2003. The impact of hydraulic blade dredging on a benthic megafaunal community in the Clyde Sea area, Scotland. J. Sea Res., 50: 45-56.

Jones & Stokes. 2006. Critical Areas Assessment Report and Habitat Management Plan for Whatcom County. Vancouver Island Transmission Reinforcement Project. August. (J&S 05197.05.) Bellevue, WA. Prepared for British Columbia Transmission Corporation.

JWEL (Jacques Whitford Environment Limited). 1994. Northumberland Strait Bridge Crossing Project, Marine Environmental Effects Monitoring Program 1993 Results. Prepared for Northumberland Strait Crossing Project. Fredericton, NB.

JWEL. 1995. Northumberland Strait Bridge Project, Marine Environmental Effects Monitoring Program 1994. Prepared for Northumberland Strait Crossing Project. Fredericton, NB.

JWEL. 2001. Atlas of Ecologically and Commercially Important Areas in the Southern Gulf of St. Lawrence. Prepared for Environmental Studies Research Funds, Calgary, AB. ESRF Report, 140: 76 pp.

JWEL. 2008. Marine Biophysical Environment Technical Study. Project Eider Rock – Proposed Petroleum Refinery and Marine Terminal in Saint John, New Brunswick. Report for Irving Oil Company Ltd., Saint John, NB. Report No. 1013263.03-005.

Kaiser, M. J., Clarke, K. R., Hinz, H., Austen, M. C. V., Somerfield, P. J., Karakassis, I. 2006. Global analysis of response and recovery of benthic biota to fishing. Marine Ecology Progress Series: Vol. 311, 1-14 pp.

KIS-ORCA Offshore Renewable and Cables Awareness. Available online at: http://www.kis-orca.eu/subsea-cables/cable-burial). Last accessed on July 8 2015.

Kranck, K. 1971. Surficial geology of the Northumberland Strait. Geological Survey of Canada, Paper 71-53. Ottawa, ON.

LeBlanc, C.H., A. Mallet, T. Surette and D. Swain. 2015. Assessment of the NAFO Division 4T southern Gulf of St. Lawrence Atlantic herring (*Clupea harengus*) stocks in 2013. DFO Can. Sci. Advis. Sec. Res. Doc., 2015/025. vi + 142 pp.

Leblanc, S. N., Benoit, H. P., Hunt, H. L. 2015. Broad-scale abundance changes are more prevalent than acute fishing impacts in an experimental study of scallop dredging intensity. Fisheries Research. 161, 8-20 pp.

Loring, D.H. and D.J.G. Nota. 1973. Morphology and sediments of the Gulf of St. Lawrence. Fish. Res. Board Can. Bull., 182: 147 pp.

Merchant, N.D., E. Pirotta, T.R. Barton and P.M. Thompson. 2014. Monitoring ship noise to assess the impact of coastal developments on marine mammals. Marine Pollution Bulletin 78:85-95.

Montevecchi, W.A. 2006. Influences of artificial light on marine birds. Ecological consequences of artificial night lighting, 94-113.

Mougeot, F., and V. Bretagnolle. 2000. Predation risk and moonlight avoidance in nocturnal seabirds. Journal of Avian Biology, 31(3), 376-386.

NBDNR (New Brunswick Department of Natural Resources). 2014. General Status of Wild Species. Available online at: http://www2.gnb.ca/content/gnb/en/departments/natural_resources/wildlife/content/GeneralStatusWildSpecies.html. Last accessed July 2, 2015.

NOAA (National Oceanic and Atmospheric Administration). 2014a. Office of Protected Resources: Atlantic White-sided Dolphin. Available online at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/whitesideddolphin_atlantic.htm. Last accessed June 24, 2015.

NOAA. 2014b. Office of Protected Resources: Long-Finned Pilot Whale. Available online at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/pilotwhale_longfinned.htm. Last accessed June 23, 2015.

Norton, S.B., S.M. Cormier, M. Smith, R.C. Jones, and M. Schubauer-Berigan. 2002. Predicting levels of stress from biological assessment data: empirical models from the Eastern Corn Belt Plains, Ohio, USA. Environ. Toxicol. Chem. 21(6): 1168-1175.

Nowacek, D.P., L.P. Thorne, D.W. Johnston and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2):81-115.

Ntengwe, F.W. 2006. Pollutant loads and water quality in streams of heavily populated and industrialized towns. Physics Chem. Earth. 31: 832-839.

O'Neill, F. G., Robertson, M., Summerbell, K., Breen, M., Robinson, L. A. 2013. The mobilization of sediment and benthic infauna by scallop dredges. Marine Environmental Research: 90, 104-112 pp.

Obert, K.M. and T.G. Brown. 2011. Ice ridge keel characteristics and distribution in the Northumberland Strait. Cold Reg. Sci. Technol., 66(2-3): 53-54.

PEIDCLE (Prince Edward Island Department of Communities, Land, and Environment). 2015. Birds of PEI. Available online at: http://www.gov.pe.ca/birds/index.php3. Last accessed June 27, 2015.

Popper, A.N. and A. Hawkins (Eds.). 2012. Effects of Noise on Aquatic Life (Vol. 730). New York. Springer.

Putman, N.F.,K.J.Lohnmann, E.M. Putman, T.P.Quinnn, A.P. Klimley, D.L.G. Noakes. Evidence for Geomagnetic Imprinting as a Homing Mechanism in Pacific Salmon. Current Biology 23, 312-316. 2013.

Richardson, J., C.R. Greene Jr, C. Malme and D. Thomson. 1995. Marine Mammals and Noise. Academic Press. San Diego.

Risch, D., P.J. Corkeron, W.T. Ellison and S.M. Van Parijs. 2012. Changes in humpback whale song occurrence in response to an acoustic source 200 km away. PLoS ONE 7(1):e29741, 29741-29746.

Rolland, R.M., S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Waaser and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society of Biology 279(1737):2363-2368.

Rondeau, A., J.M. Hanson and M. Comeau. 2014. Rock crab, *Cancer irroratus*, fishery and stock status in the southern Gulf of St. Lawrence: LFA 23, 24, 25, 26A and 26B. DFO Can. Sci. Advis. Sec. Res. Doc., 2014/032: vi + 52 pp.

Santos, C. D., Miranda, A. C., Granadeiro, J. P., Lourenço, P. M., Saraiva, S., and Palmeirim, J. M. 2010. Effects of artificial illumination on the nocturnal foraging of waders. Acta Oecologica, 36(2), 166-172.

Scott, W.B. and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci., 219: 731 pp.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4).

Species at Risk Public Registry. 2015. Advanced Species Search for Taxonomy: Fishes (marine); Range: New Brunswick, Nova Scotia, Prince Edward Island, Quebec; COSEWIC Status: Endangered, Special Concern, Threatened; Schedule: No schedule, Schedule 1, Schedule 2, Schedule 3; SARA Status: All. Available online at: http://www.sararegistry.gc.ca/search/SpeciesSearch_e.cfm. Last accessed June 25, 2015.

Stenson, G.B. and M.O. Hammill. 2012. Living on the edge: Observations of Northwest Atlantic harp seals in 2010 and 2011. DFO Can. Sci. Advis. Sec. Res. Doc., 2011/108: iv + 12 pp.

Sundermeyer, J.K., K. Lucke, M. Dahne, A. Gallus, K. Krugel and U. Siebert. 2012. Effects of Underwater Explosions on Presence and Habitat Use of Harbor Porpoises in the German Baltic Sea. In A. N. Popper & A. Hawkins (Eds.), Effects of Noise on Aquatic Life. Vol. 730, 289-291.

Swail, V.R., V.J. Cardone, M. Ferguson, D.J. Gummer, E.L. Harris, E.A. Orelup and A.T. Cox. 2006. The MSC50 Wind and Wave Reanalysis. 9th International Wind and Wave Workshop, September 25-29, Victoria, BC. 29 pp.

Thomas G.B. J.S. Tibbo, D. Tripathi, K. Obert and N. Shrestha. 2010. Extreme ice load events in the Confederation Bridge. Cold Reg. Sci. Technol., 60(1): 1-14.

Thomsen, F., C. Mueller-Blenkle, A. Gill, J. Metcalfe, P.K. McGregor, V. Bendall, M.H. Andersson, P. Sigray and D. Wood. 2012. Effects of Pile Driving on the Behavior of Cod and Sole. In A. N. Popper & A. Hawkins (Eds.), Effects of Noise on Aquatic Life. Vol. 730, 387-388.

Tougaard, J., L.A. Kyhn, M. Amundin, D. Wennerberg and C. Bordin. 2012. Behavioral Reactions of Harbor Porpoises to Pile-driving Noise. In A. N. Popper & A. Hawkins (Eds.), Effects of Noise on Aquatic Life. Vol. 730, 277-280.

Walker, M.M., T.E., Dennis, J.L. Kirschvink. The magnetic sense and its use in long-distance navigation by animals. Current Opinion in Neurobiology, 12, 735-744.

Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson and D. Mackie. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21(8-10):1005-1027.

Watling, L., Findlay, R. H., Mayer, L. M., Schick, D. F. 2001. Impact of a scallop drag on the sediment chemistry, microbiota, and faunal assemblages of a shallow subtidal marine benthic community. Journal of SEA Research: 46, 309-324 pp.

Weldon, J., D. Garbary, S. Courtenay, W. Ritchie, C. Godin, M-H. Thériault, M. Boudreau and A. Lapenna. 2005. The Community Aquatic Monitoring Project (CAMP) for measuring marine environmental health in coastal waters of the southern Gulf of St. Lawrence: 2004 Overview. Can. Tech. Rep. Fish. Aquat. Sci., 2624: viii + 53 pp.

Wiese, F.K., W.A. Montevecchi, G. Davoren, F. Huettmann, A.W. Diamond and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the North Atlantic. Marine Pollution Bulletin 42: 1285-1290.

Williams, R., C. Erbe, E. Ashe, A. Beerman and J. Smith. 2013b. Severity of killer whale behavioural responses to ship noise: A dose-response study. Marine Pollution Bulletin http://dx.doi.org/10.1016/j.marpolbul.2013.12.004.

Williams, R., C.W. Clark, D. Ponirakis and E. Ashe. 2013a. Acoustic quality of critical habitats for three threatened whale populations. Animal Conservation 17(1):12.

Commercial Fisheries

CFIA. 2015. Canadian Shellfish Sanitation Program. Available online at: http://www.inspection.gc.ca/food/fish-and-seafood/shellfish-sanitation/eng/1299826806807/1299826912745. Last accessed July 10, 2015.

DFO Science. 2011. Assessment of the Scallop Fishery (Placopecten magellanicus) of the Southern Gulf of St. Lawrence. Canadian Science Advisory Secretariat Science Advisory Report 2011/039.

DFO Science. 2013a. American Lobster, Homarus Americanus, Stock Status in the Southern Gulf of St. Lawrence: LFA 23, 24, 25, 26A and 26B. Canadian Science Advisory Secretariat Science Advisory Report 2013/029.

DFO Science. 2013b. Assessment of the Rock Crab (Cancer Irroratus) Fishery in the Southern Gulf of St. Lawrence for 2006 to 2011. Canadian Science Advisory Secretariat Science Advisory Report 2013/030.

DFO. 2012. Government of Canada: Aboriginal Fisheries Strategy. Available online at: http://www.dfo-mpo.gc.ca/Fm-Gp/aboriginal-autochtones/afs-srapa-eng.htm. Last accessed July 10, 2015.

DFO. 2013a. Fisheries Management Policies online at: http://www.dfo-mpo.gc.ca/fm-gp/policies-politiques/index-eng.htm. Last accessed July 15, 2015.

DFO. 2013b. Aquaculture Sites Cape Traverse-Victoria. Available online at: http://www.inter.dfo-mpo.gc.ca/Gulf/PEI-Aquaculture-Leasing/Maps?todo=region&region_map=capetraverse-victoria. Last accessed July 10, 2015.

DFO. 2015a. Notice to Recreational Anglers: Striped Bass Recreational Fishery in the Southern Gulf of St. Lawrence for 2015 and 2016. Available online at: http://www.glf.dfo-mpo.gc.ca/Gulf/FAM/Recreational-Fisheries/2015-16-Striped-Bass. Last accessed July 10, 2015.

DFO. 2015b. Notice to Recreational Anglers: 2015 Recreational Groundfish Fishery – Southern Gulf of St. Lawrence. Available online at: http://www.glf.dfo-mpo.gc.ca/Gulf/FAM/Recreational-Fisheries/2015-Recreational-Groundfish-Fishery. Last accessed July 10, 2015.

Justice Laws. 2015a. Government of Canada: Fisheries Act online at: http://laws-lois.justice.gc.ca/eng/acts/F-14/. Last accessed on July 30, 2015.

Justice Laws. 2015b. Government of Canada: Maritime Provinces Fishery Regulations. Available online at: http://laws-lois.justice.gc.ca/eng/regulations/sor-93-55/index.html. Last accessed July 10, 2015.

Lavoie, Cécile. Personal communication, July 6, 2015. Regional Fisheries and Aquaculture Management Officer, DFO, Moncton, New Brunswick.

Mallet, Pierre. Personal communication, July 6, 2015. Regional Senior Fisheries and Aquaculture Management Officer, DFO, Moncton, New Brunswick.

New Brunswick Agriculture, Aquaculture and Fisheries. No date. Aquaculture site locations. Available online at: http://daafmaapextweb.gnb.ca/spatialfusionviewer/mapViewer/map.action?request_locale=en&zoom=8&lat=5846515.41867&lon=-7392072.13037&theme=Aquaculture%20Sites. Last accessed July 10, 2015.

Archaeology and Heritage Resources

Aboriginal Affairs Secretariat (AAS). 2014. Holland (1765), Meecham (1860), and Lake (1863) historical maps for the Borden/Carleton area. Prince Edward Island Aboriginal Affairs Secretariat, Department of Intergovernmental and Public Affairs, Charlottetown.

Archaeological Assessments in New Brunswick. Archaeological Services, Heritage Branch, New Brunswick Department of Tourism, Heritage and Culture, Fredericton.

Archaeological Services. 2012. *Guidelines and Procedures for Conducting Professional*

Archaeological Services. 2014a. Archaeological Potential Map for the Maritime Electric Transmission Line Project. PDF Map received October 8, 2014.

Archaeological Services. 2014b. Archaeological Potential Map for the Maritime Electric Transmission Line Project. Digital Spatial Data received November 2, 2014.

Canadian Seabed Research Ltd. (CSR). 2015. *Northumberland Strait Cable Route Assessment: 2014 Marine Geophysical Survey*. Report prepared for Maritime Electric Company Ltd., CSR Project Number 1401, March 23, 2015.

Use of Land And resources for Traditional Purposes by Aboriginal Persons

Aboriginal Affairs and Northern Development Canada (AANDC). 2014. First Nation Profiles Available at: http://fnpim-cippn.aandc-aadnc.gc.ca/index-eng.asp Last accessed on June 25, 2015.

Berneshawi, Suzanne. 1997. Resource Management and the Mi'kmaq Nation. Available online at: http://www3.brandonu.ca/library/CJNS/17.1/cjnsv17no1_pg115-148.pdf. Last accessed on June 29, 2015.

DFO. 2012. Government of Canada: Aboriginal Fisheries Strategy online at: http://www.dfo-mpo.gc.ca/Fm-Gp/aboriginal-autochtones/afs-srapa-eng.htm. Last accessed on July 10, 2015.

Fisheries and Oceans Canada (DFO) 2014. Lobster Fishing Areas. Available online at: http://www.glf.dfo-mpo.gc.ca/Gulf/Fishing-Area-Maps/Lobster. Last accessed on July 8, 2015.

Ganong, W.F. 1899. Map of New Brunswick in Prehistory (Indian) Period.

Lavoie, Cécile. Personal communication, July 6, 2015. Regional Fisheries and Aquaculture Management Officer, DFO, Moncton, New Brunswick.

Leblanc, Isabelle. Personal communication, July 3, 2015. Regional Manager, Aboriginal Fisheries, Fisheries and Aquaculture Management Branch, DFO, Moncton, New Brunswick.

Paul, D. No Date. MAP: Land of the Mi'Kmaq – Mi'kma'ki, We were not the Savages, First Nation History. Available online at: http://www.danielnpaul.com/Map-Mi'kmaqTerritory.html. Last accessed on June 17, 2015.

polygon dataset of Aboriginal Lands, created using ArcGIS software, from sources on Natural Resources Canada, Earth Sciences Sector, Surveyor General Branch. Download 27th April 2015, DSPRY from: http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/815dd99d-4fbd-47cc-be02-7ad4b03a23ec.html.

Stantec Consulting Ltd. (Stantec). 2015. 2014 Archaeological Impact Assessment (Walkover) for the New Brunswick – Prince Edward Island Transmission Line Interconnection Project – New Brunswick Land Based Portion. Fredericton, NB.

Effects of Environment on the Project

Bernier, N., J. MacDonald, J. Ou, H. Ritchie, and K. Thompson. 2006. Storm surge and meteorological modelling. In Impacts of Sea Level Rise and Climate Change on the Coastal Zone of South eastern New Brunswick, (ed.) R. Daigle, D. Forbes, G. Parkes, H. Ritchie, T. Webster, D. Bérubé, A. Hanson, L. DeBaie, S. Nichols and L. Vasseur, Environment Canada, 613 pp.

Bindoff, N.L., J. Willebrand, V. Artale, A, Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, Canadian Coast Guard. 2013. Chapter 3: Ice Climatology and Environmental Conditions in Ice Navigation in Canadian Waters. Available online at: http://www.ccg-gcc.gc.ca/Icebreaking/Ice-Navigation-Canadian-Waters. Last accessed July 9, 2015

Catto, N.R. 2006. Impacts of Climate Change and Variation on the Natural Areas of Newfoundland and Labrador. Newfoundland Ministry of Environment and Conservation, St. John's NF, 160 pp.

CBC News. (2015a, March 22). Confederation Bridge closed to all traffic. Available online at: http://www.cbc.ca/news/canada/prince-edward-island/confederation-bridge-closed-to-all-traffic-1.3004821. Last accessed July 9, 2015.

CBC News. (2015b, May 4). Northumberland Strait ferry service expected to begin Friday. Available online at: http://www.cbc.ca/news/canada/nova-scotia/northumberland-strait-ferry-service-expected-to-begin-friday-1.3059948. Last accessed June 17, 2015.

Daigle, R., D. Forbes, G. Parkes, H. Ritchie,T. Webster, D. Bérubé, A. Hanson, L. DeBaie, S.

Environment Canada. 2014. Weather and Meteorology – Glossary. Available online at: http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=B8CD636F-1&def=allShow#wsglossaryF. Accessed on July 13, 2014. Last accessed June 29, 2015

GOC (Government of Canada). 2015a. Canadian Climate Normals: Summerside, PEI. Available online at: http://climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html. Accessed on June 23, 2015.

GOC. 2015b. Canadian Climate Normals: Charlottetown, PEI. Available online at: http://climate.weatheroffice.ec.gc.ca/climate_normals/ index_e.html. Accessed on June 23, 2015.

GOC. 2015c. Get Prepared; Hazards and Emergencies; Regional Hazards: New Brunswick. Available online at: http://www.getprepared.gc.ca/cnt/hzd/rgnl/nb-en.aspx. Last accessed June 25, 2015.

Government of Newfoundland and Labrador. 2003. Newfoundland and Labrador Climate Change Discussion Paper, Department of the Environment. 28 pp. Available online at: http://www.env.gov.nl.ca/env/Env/PollPrev/pdf/climatechange_paper.pdf. Last accessed June 27, 2015.

IBC (Insurance Bureau of Canada). 2012. Telling the Weather Story. Prepared by the Institute for Catastrophic Loss Reduction for the Insurance Bureau of Canada, June 2012. Available online at: http://iclr.org/images/Telling_the_weather_story.pdf. Last accessed June 23, 2015.

IESO (Independent Electricity System Operator. 2010. Glossary of Standard Operating Terms, Part 7.6 *in* Market Manual 7: System Operations. Document ID IMP_GOT_0002 Available online at: http://www.ieso.ca/Documents/systemOps/so_Glossary.pdf. Last accessed July 13,2015.

IPCC (Intergovernmental Panel on Climate Change). 2007. Appendix I: Glossary; in Climate Change 2007: Impacts, Adaptation and Vulnerability (Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change); (ed.) M.I. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson; Cambridge University Press, Cambridge United Kingdom, p. 869-883. Available online at: https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-app.pdf. Last accessed June 24, 2015.

IPCC. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

Lines, G.S., M. Pancura, and C. Lander. 2005. Building Climate Change Scenarios of Temperature and Precipitation in Atlantic Canada using the Statistical Downscaling Model (SDSM). Environment Canada, Meteorological Service of Canada, Atlantic Region. Science Report Series No. 2005-9, October 2005.

Lines, G.S., M. Pancura, C. Lander, and L. Titus. 2008. Climate Change Scenarios for Atlantic Canada Utilizing a Statistical Downscaling Model Based on Two Global Climate Models. Environment Canada, Meteorological Service of Canada, Atlantic Region. Science Report Series 2009-1, July 2008.

NAV CANADA.2000. The Weather of Atlantic Canada and Eastern Quebec. Available online at: http://www.navcanada.ca/EN/media/Publications/Local%20Area%20Weather%20Manuals/LAWM-Atlantic-EN.pdf. Last accessed July 2, 2015.

Nicholos, and L. Vasseur (ed). 2006. Impacts of Sea Level Rise and Climate Change on the Coastal Zone of South eastern New Brunswick. Environment Canada, 613 pp.

NRCan (Natural Resources Canada). 2001. The Tides of Change: Climate Change in the Atlantic Provinces. Shaw, J. Geological Survey of Canada, Miscellaneous Report no. 75, 2001; 1 sheet, doi:10.4095/212738Phillips, D. 1990. The Climate of New Brunswick. In *Climates of Canada*. Minister of Supply and Services Canada.

NRCan. 2010a. Potential Impacts: Coastal Sensitivity to Sea-Level Rise. Available online at: http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/dc9817c0-8893-11e0-82bc-6cf049291510.html. Last accessed July 15, 2015.

NRCan. 2010b. National Building Code of Canada Volume 1. Available online at: http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_building_code.html. Last accessed July 15, 2015.

NRCan. 2013a. Seismic Design Tools for Engineers: Ground Motion Parameters for Use with the National Building Code of Canada. Natural Resources Canada, Ottawa, Ontario. 2013. Available online at: http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index-eng.php. Last accessed July 2, 2015.

NRCan. 2013b. Frequently Asked Questions about Earthquakes (FAQ). Available online at: http://earthquakescanada.nrcan.gc.ca/info-gen/faq-eng.php#magnitude. Last accessed July 15, 2015.

Parkes, G.S. Ketch, L., and C.T. O'Reilly. 1997. Storm surge events in the Maritimes. *In* Skafel, M.G. (Ed) Proceedings of the 1997 Canadian Coastal Conference May 1997, Guelph, Ontario. Canadian Coastal Science and engineering association, pp 115-129.

PEIDELJ. 2011. Coastal Erosion and Climate Change. Available online at: http://www.csrpa.ca/sites/default/files/fichiers/coastal_erosion_and_climate_change_0.pdf. Last accessed July 15, 2015.

Phillips, D. 1990. The Climate of New Brunswick. In *Climates of Canada*. Minister of Supply and Services Canada.

PIEVC. 2014. The PIEVC Engineering Protocol for Infrastructure Vulnerability Assessment and Adaptation to a Changing Climate. Public Infrastructure Engineering Vulnerability Committee, Engineers Canada. Available online at: http://www.pievc.ca/e/doc_list.cfm?dsid=43. Last accessed July 6, 2015.

S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan. 2007. Observations: Oceanic Climate Change and Sea Level. *In* Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available at http://ipcc-wg1.ucar.edu/wg1/wg1- report.html.

Samuel Engineering. 2013. Canadian National Instrument 43-101 Technical Report on the Sisson Project, New Brunswick, Canada. Prepared by Samuel Engineering, Inc. on behalf of Northcliff Resources Ltd., Greenwood Village, Colorado. January 22, 2013.

Stantec Consulting Ltd. 2013. Environmental Protection Plan – Maritime Electric Company, Limited High Powered transmission Construction, Prince Edward Island. Prepared for Maritime Electric Company, Limited.

University of Prince Edward Island. 2015. It's Official! 2014-15 Snowiest Winter on Record – UPEI Climate Lab. Available online at: http://projects.upei.ca/climate/2015/04/29/its-official-2014-15-snowiest-winter-on-record/. Last accessed July 14, 2015.

Vasseur, L. and N. Catto. 2008. Atlantic Canada; In From Impacts to Adaptation: Canada in a Changing Climate 2007, edited by D.S. Lemmen, F.J. Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 119-170.

Accidents and Malfunctions

Transport Canada. 2009. Guidelines for Navigating Under the Confederation Bridge. December 2003. Revised December 2009. Available online at: http://www.tc.gc.ca/publications/EN/TP13681/PDF/HR/TP13681E.pdf. Last accessed July 4, 2015.

Transport Canada. 2010. Construction Standards for Small Vessels TP 1332E. 2004. Revised 2010. Available online at: https://www.tc.gc.ca/eng/marinesafety/tp-tp1332-docinfo-2152.htm. Last accessed July 4, 2015.

APPENDIX A

MCPEI Letter

Stantec

PEI-NEW BRUNSWICK CABLE INTERCONNECTION UPGRADE PROJECT - VOLUME 4, THE NORTHUMBERLAND STRAIT

September 30, 2015

Mi'kmaq
Confederacy of
Prince Edward Island

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Tel: (902) 436-5101
Fax: (902) 436-5655

Polyclinic
Professional Centre
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199 Grafton Street
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C1A 1L2
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GCB

RECEIVED
JUN 05 2015

WITHOUT PREJUDICE

1 June 2015

Greg C. Buchanan, M.Sc., R.P.A.
Archaeologist
Stantec
845 Prospect Street Fredericton NB E3B 2T7

Dear Mr. Buchanan:

Re: Archaeological Impact Assessment: Maritime Electric transmission line and substation in Borden, PID 380477, Prince County, Prince Edward Island,

Further to your email message of May 07, 2015, I am writing in relation to the archaeological impact assessment for Maritime Electric transmission line and substation in Borden, PID 380477, your organization is reviewing. Based on our research, historical and traditional Mi'kmaq use occurs outside of the area you have designated for the archaeological impact assessment. This use includes: campsites along the now Confederation Trail area to the north of the area, and a travel route to the east of the area. As well, fish harvesting of mackerel occurs in the waters to the south of the area.

It must be remembered that the MCPEI database is, to date, a partial inventory of existing knowledge. As such, it does not mean that the subject area was not used (or used for additional purposes), rather that evidence of use, if it exists, has not yet been collected.

I trust this is the information required. Please advise as to what the next steps might be in this archaeological impact assessment process.

The response provided herein is specific to the particular activity (ies) in the particular area(s) specified in the information provided by you. Should you have any questions, please do not hesitate to contact me.

Yours truly,

Donald K. MacKenzie
Executive Director
Mi'kmaq Confederacy of PEI

cc. Tammy MacDonald
Randy Angus
Lennox Island FN
Abegweit FN
Helen Kristmanson
Barry MacPhee

Abegweit
First Nation

Lennox
Island
First Nation

www.mcpei.ca