7.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS ON THE MARINE ENVIRONMENT

The marine environment VC includes consideration of marine fish and fish habitat, and marine wildlife and wildlife habitat. Special consideration is given to marine species at risk (SAR) and commercial, recreational, and Aboriginal (CRA) fishery species.

These components constitute a marine environment VC as a result of:

- regulations protecting fish and fish habitat;
- the intrinsic relationship of fish and fish habitat to the local CRA fisheries and local communities;
- the potential environmental effects of the Project on marine fish and fish habitat, and marine wildlife (i.e., sea turtles, marine mammals, and marine birds) and wildlife habitat;
- ecological, economic, and recreational importance of fish and the fishery; and
- the relationship between the marine environment and other VCs, such as the commercial, recreational, and Aboriginal fisheries VC and the current use of land and resources for traditional purposes by Aboriginal persons VC.

7.1 REGULATORY AND POLICY SETTING

7.1.1 Species at Risk and Species of Conservation Concern

With respect to fish and marine wildlife, this VC focuses particularly on marine species at risk (SAR) and species of conservation concern (SOCC). SAR include those marine species listed under the Schedule A of the New Brunswick *Species at Risk Act* (NB *SARA*), or listed as *extirpated*, *endangered*, or *threatened* under Schedule 1 of the federal *Species at Risk Act* (*SARA*). By definition, the species listed in these Acts are afforded legal protection under either provincial or federal legislation which does not extend to more common species.

SOCC are not listed under federal or provincial legislation, but are considered rare in New Brunswick, or the long-term sustainability of their populations has been evaluated as tenuous. SOCC are defined here as species listed as *extirpated*, *endangered*, *threatened*, or of *special concern* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). SOCC also includes species listed as *special concern* under Schedule 1, or listed with any designation under Schedule 2 and 3, of *SARA*. The Atlantic Canada Conservation Data Centre (AC CDC) conservation status ranking ("S-rank") has also been reviewed and SOCC includes species that have been assigned a sub-national (provincial) ranking of *S1* (*critically imperiled*), *S2* (*imperiled*), or *S3* (*vulnerable*) in New Brunswick (AC CDC 2017).

SOCC are not afforded any direct protection by either federal or provincial legislation. SOCC are included in this VC as a precautionary measure, reflecting observations and trends in their provincial population status, and are often important indicators of ecosystem health and regional biodiversity. Rare species are often an indicator of the presence of unusual and/or sensitive habitat; their protection as umbrella species can confer protection on their associated unusual habitats and co-existing species.

Additional details regarding the federal protection afforded *SARA* and the NB *SARA* are provided below, along with other relevant legislation, regulations and policies.

Species at Risk Act

The federal *SARA* focuses on protecting species and their associated habitat whose populations are not secure. Sections 32, 33 and 58 of *SARA* contain provisions to protect species listed on Schedule 1 of *SARA* and their critical habitat, including prohibitions that make it an offence to engage in certain activities affecting species listed as *extirpated*, *endangered*, or *threatened*. Critical habitat is defined under Section 2(1) of *SARA* as "*habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or action plan for the species*".

Under Section 79 of *SARA*, Ministerial notification is required if a project "*is likely to affect a listed wildlife species or its critical habitat*". This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

New Brunswick Species at Risk Act

Species at risk in New Brunswick are protected under the New Brunswick *Species at Risk Act* (NB *SARA*), which shares many similarities with the federal *SARA*. The NB *SARA* is administered by the New Brunswick Department of Energy and Resource Development (NBDERD) 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*".

7.1.2 Other Relevant Legislation, Regulations, and Policy

Fisheries Act

The federal *Fisheries Act* protects fish, including "marine animals" such as marine mammals and sea turtles. 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 nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order 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 among others temperature, salinity, dissolved oxygen (DO), total suspended solids (TSS), and turbidity, for example.

The *Fisheries Act* focuses on protecting the productivity of CRA fisheries, including a prohibition in Section 35 of the Act against causing "serious harm" to fish (i.e., the death of fish or any permanent alteration to, or destruction of, fish habitat) that are part of or support a CRA fishery (DFO 2013a). CRA fisheries are defined by the *Fisheries Act* as follows:

- "*Commercial, in relation to a fishery: means that the fish is harvested under the authority of a licence for the purpose of sale, trade or barter.*"
- "*Recreational, in relation to a fishery: means that fish is harvested under the authority of a licence for personal use of the fish or for sport*."
- "*Aboriginal, in relation to a fishery: means that fish is harvested by an Aboriginal organization or any of its members for the purpose of using the fish as food, for social or ceremonial purposes or for purposes set out in a land claims agreement entered into with the Aboriginal organization*."

Proponents of projects that cause serious harm to fish are required to obtain a *Fisheries Act* Authorization under Section 35(2) and to offset that harm to maintain and enhance the productivity of the fishery (DFO 2013b). Section 36(3) of the *Fisheries Act* prohibits the deposition of a deleterious substance in waters frequented by fish. Additional information regarding the regulatory and policy setting for CRA fisheries is provided in the context of the CRA Fisheries VC (Section 11.1)

The *Marine Mammal Regulations* of the *Fisheries Act* are intended to protect marine mammals, specifically Section 7.0, which states, "*No person shall disturb a marine mammal except when fishing for marine mammals under the authority of these regulations*".

Oceans Act

The *Oceans Act* is intended to promote the sustainability of marine species and protects their habitat through the establishment of marine protected areas.

Migratory Birds Convention Act

Migratory birds (including most marine bird species) are protected federally under the *Migratory Birds Convention Act* (*MBCA*), which is administered by Environment and Climate Change Canada (ECCC). The *MBCA* and associated regulations provide protection to all birds listed in the Canadian Wildlife Service (CWS) *Occasional Paper No. 1, Birds Protected in Canada under the Migratory Birds Convention Act* (CWS 1991). Migratory birds protected by the Act generally include all seabirds (except cormorants and pelicans), all waterfowl, all shorebirds, and most landbirds (birds with principally terrestrial life cycles). The Act and associated regulations state that no person may disturb, destroy, or take/have in their possession a migratory bird (alive or dead), or its nest or eggs, except under authority of a permit. Section 5.1 of the *MBCA* describes prohibitions related to depositing substances harmful to migratory birds: "*No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area*".

The *Migratory Birds Sanctuary Regulations* pursuant to the *MBCA* prescribe migratory bird sanctuaries and provide for their control and management. As per Section 10(1) of the Regulations, no person shall, in a migratory bird sanctuary, carry on any activity that is harmful to migratory birds or the eggs, nests or habitat of migratory birds, except under authority of a permit.

New Brunswick Clean Environment Act—Water Quality Regulation

The *Water Quality Regulation* is the main regulatory instrument in New Brunswick 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) is 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* (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 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 New Brunswick 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.

7.2 POTENTIAL ENVIRONMENTAL EFFECTS, PATHWAYS, AND MEASURABLE PARAMETERS

Project activities and components could potentially interact with the marine environment to result in adverse environmental effects on marine populations. In consideration of these potential interactions, the assessment of Project-related environmental effects on the marine environment is therefore focused on the following environmental effect:

- change in marine populations.

The environmental effect pathways and measurable parameters are provided in Table 7.1.

Table 7.1 Potential Environmental Effects, Environmental Effects Pathways, and Measurable Parameters for the Marine Environment

Potential Environmental Effect	Environmental Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in marine populations	• Change in benthic habitat quantity or quality due to direct alteration of the seabed • Increased risk of direct injury or mortality (e.g., due to smothering during cable burial or vessel collision) • Increased risk of exposure to marine contaminants • Increased risk of exposure to underwater acoustic emissions at levels capable of causing sensory disturbance or auditory injury • Increased risk of exposure to electromagnetic fields (EMF) at levels capable of causing sensory disturbance	• Area of habitat permanently affected (m^2) • Mortality (qualitative likelihood of mortality, or direct measurement of number of individuals lost) • Change in chemical composition of water (unit depends on the contaminant, but typically in units of mass of contaminant per unit volume) • Change in chemical composition of sediment (unit depends on the contaminant, but typically in units of mass of contaminant per mass of sediment) • Extent (km from source) and intensity (deciBels or dB) of underwater acoustic emissions • Extent (km from source) and intensity of EMF (milliGauss or mG)

7.3 BOUNDARIES

7.3.1 Spatial Boundaries

The PDA for the Project is defined in Section 2.1. Of particular relevance to the marine environment VC is the portion of the PDA below the higher high water large tide (HHWLT), which is referred to in the context of this VC assessment as the "marine PDA" and includes:

- two 10 m wide corridors extending across Head Harbour Passage, from HHWLT on the eastern coast of Deer Island (Chocolate Cove) to HHWLT on the western coast of Campobello Island (Wilsons Beach); one corridor each for the proposed and existing cables.
- two 10 m wide corridors extending across Grand Manan Channel, from HHWLT on the eastern coast of Campobello Island (Little Whale Cove) to HHWLT on the northern coast of Grand Manan Island (Long Eddy Point); one corridor each for the proposed and existing cables.

The marine PDA for both the existing and proposed cables is 10 m wide along its entire length to be consistent in the assessment process for all Project-related construction and decommissioning activities; however, the actual footprint of disturbance for removal of the existing cables and placement of the proposed cables will be narrower in certain areas of the marine PDA:

- the actual footprint of disturbance for removal of the existing subsea cables (if they are removed at the end of their service life rather than abandoned in place) will be 4 m wide in the portions of the marine PDA that are in Head Harbour Passage and Grand Manan Channel and are at water depths of more than 3 m below the lower low water large tide (LLWLT) (i.e., the portions of the marine PDA beyond the intertidal zone in the subtidal zone).
- the actual footprint of disturbance for placement of the proposed subsea cables will be 2 m wide in the portions of the marine PDA that are in Head Harbour Passage and are at water depths of more than 3 m below LLWLT (i.e., the portions of the marine PDA beyond the area in which horizontal directional drilling (HDD) or open-cut trenching (OCT) will be used at the landfall sites).

The local assessment area (LAA) is the maximum area where Project-specific environmental effects can be predicted and measured with a reasonable degree of accuracy and confidence. The LAA for the marine environment VC includes the marine PDA area and extends 1 km on either side of the marine PDA.

The PDA and LAA for the marine environment VC are illustrated in Figure 7.1 for the Head Harbour Passage segment of the Project, and Figure 7.2 for the Grand Manan Channel segment of the Project.

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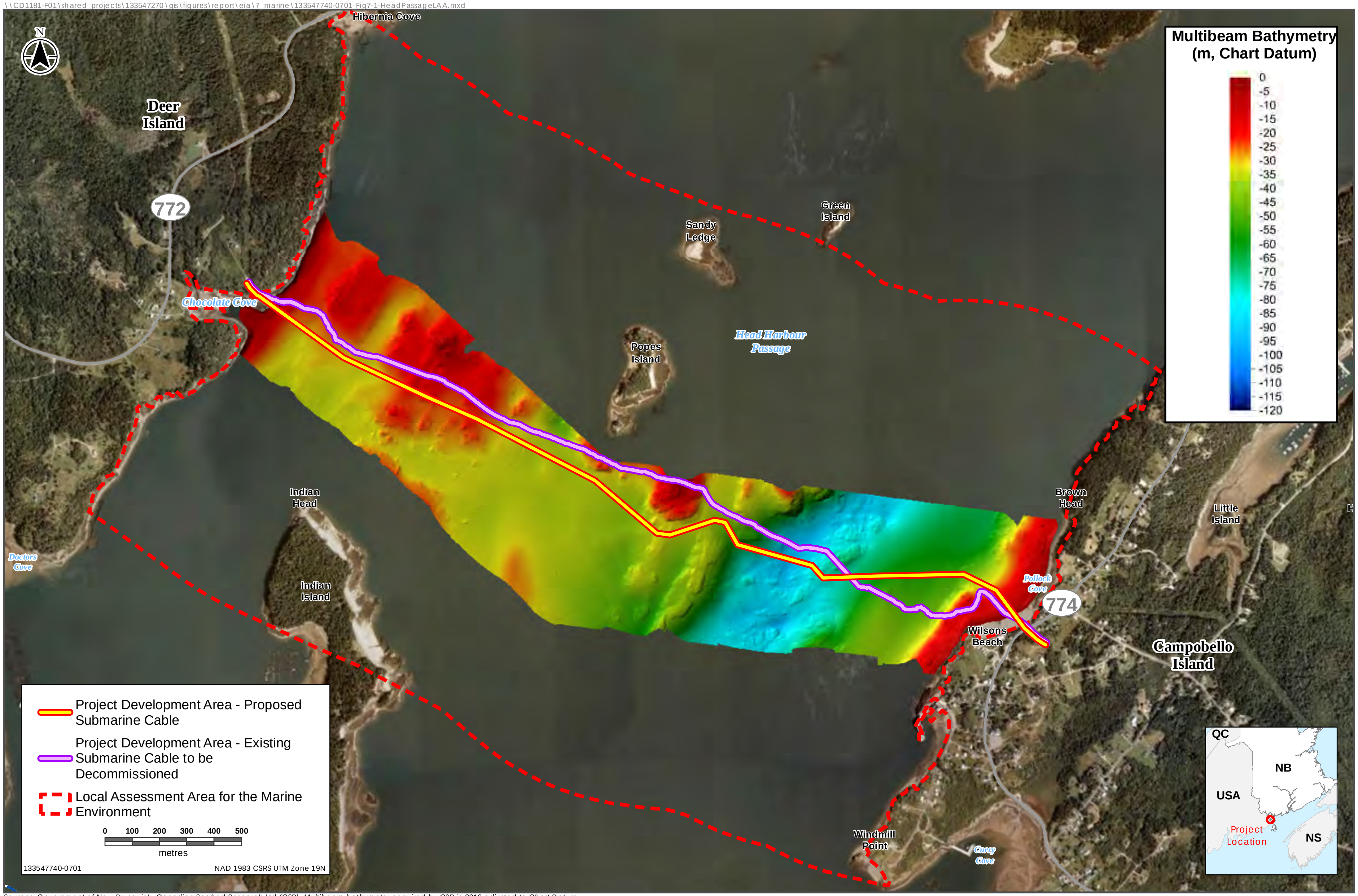

Sources: Government of New Brunswick, Canadian Seabed Research Ltd (CSR). Multibeam bathymetry acquired by CSR in 2016 adjusted to Chart Datum.

Local Assessment Area for the Marine Environment - Head Harbour Passage

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133547740 - FUNDY ISLES - NB POWER

Figure 7.1

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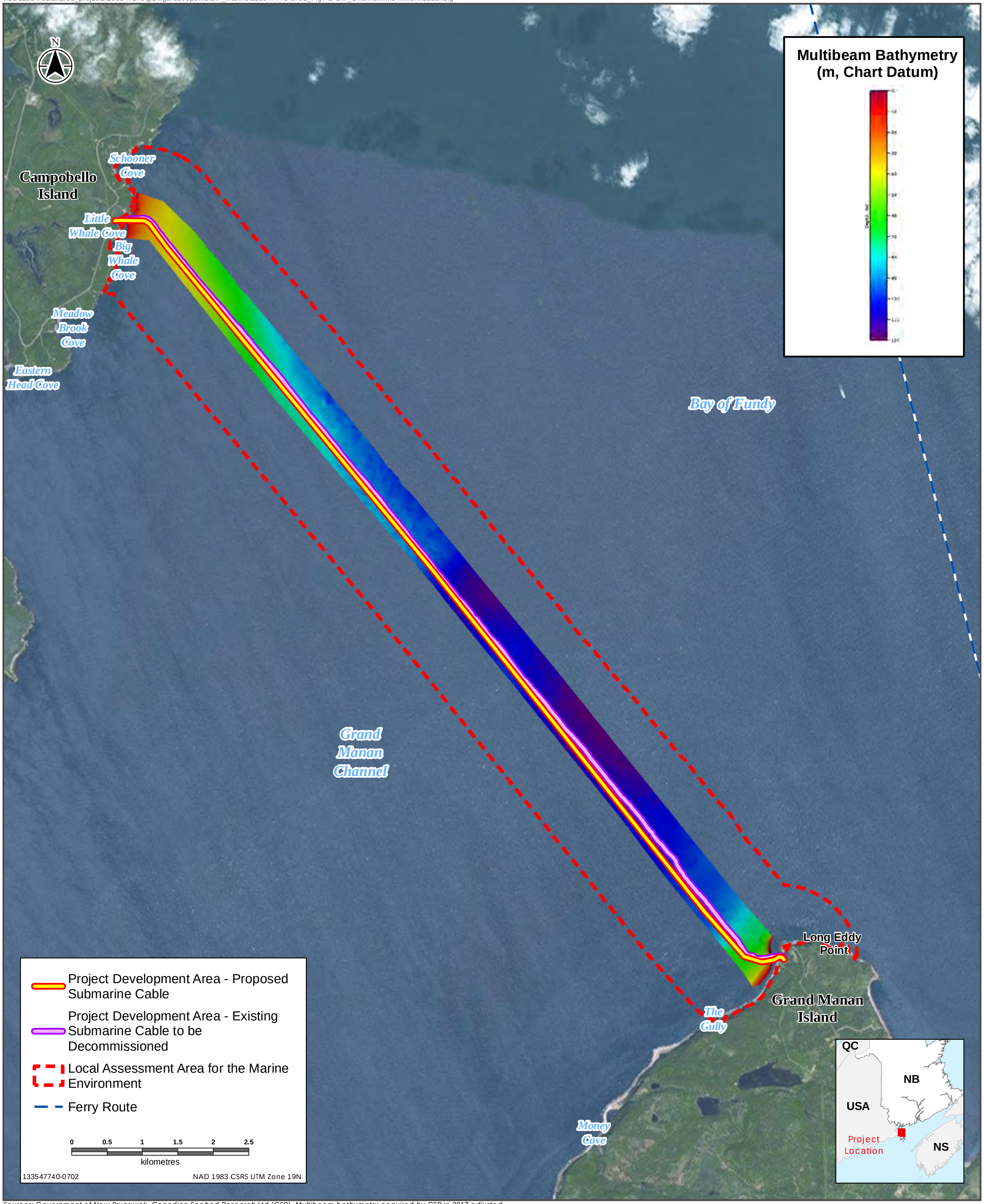

Sources: Government of New Brunswick, Canadian Seabed Research Ltd (CSR). Multibeam bathymetry acquired by CSR in 2017 adjusted

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

Local Assessment Area for the Marine Environment - Grand Manan Channel

Stantec

133547740 - FUNDY ISLES - NB POWER

Figure 7.2

7.3.2 Temporal Boundaries

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

- construction – scheduled to begin in the spring of 2018 and last for approximately 16 months; and
- operation – scheduled to begin in late 2019 and continue for the life of the new submarine cables, currently anticipated to be at least 40 years.

Decommissioning pertains to both the existing cables and the proposed cables. Decommissioning of the existing cables will occur at some time following the successful completion of the proposed installation of the new subsea cables as per current regulations and requirements. Decommissioning of the proposed new subsea cables will occur following the useful service life of the submarine cables, and will be carried out in accordance with regulations in place at that time.

7.4 SIGNIFICANCE DEFINITION AND RESIDUAL ENVIRONMENTAL EFFECTS CHARACTERIZATION

For the purposes of this environmental effects assessment, a significant adverse residual environmental effect on the marine environment is defined as a residual Project-related environmental effect that:

- causes a decline in abundance or change in distribution of marine populations within the outer Bay of Fundy, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for a *SARA* Schedule 1-listed species;
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan (developed as a result of Section 65 of *SARA)* or a non-compliance with the management plan (developed as a result of Section 20 of NB *SARA*); or
- results in serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery under the *Fisheries Act* that is unauthorized, unmitigated, or not compensated through offsetting measures in accordance with Fisheries and Oceans Canada's (DFO's) Fisheries Protection Policy Statement (DFO 2013a).

Criteria used to characterize and describe residual environmental effects for the assessment on the marine environment are provided in Table 7.2.

Table 7.2 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 environmental effect	**Positive** – the residual environmental effect moves measurable parameters in a direction beneficial to the marine environment relative to baseline. **Adverse** – the residual environmental effect moves measurable parameters in a direction detrimental to 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 relative to existing baseline conditions. **Low** – a measurable change that is within the range of natural variability and does not pose a risk to the short-term viability of marine populations. **Moderate** – a measurable change that may exceed natural variability but does not pose a risk to the long-term viability of marine populations. **High** – a measurable change that exceeds the limits of natural variability and may affect the long-term viability of marine populations.
Geographic Extent	The geographic area in which an environmental effect occurs	**PDA** – the residual environmental effect is restricted to the marine PDA (refer to Section 7.3.1). **LAA** – the residual environmental effect extends into the LAA for the marine environment VC (refer to Section 7.3.1).
Frequency	Identifies when the residual environmental effect occurs and how often during the Project or in a specific phase	**Single event** – the residual environmental effect occurs only once. **Multiple irregular event** – the residual environmental effect occurs at no set schedule. **Multiple regular event** – the residual environmental effect occurs at regular intervals. **Continuous** – the residual environmental effect occurs continuously.
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual environmental effect can no longer be measured or otherwise perceived.	**Short-term** – the residual environmental effect is restricted to the duration of construction. **Medium-term** – the residual environmental effect is measurable for up to two years following completion of construction. **Long-term** – the residual environmental effect extends throughout operation of the Project but is not permanent. **Permanent** – the residual environmental effect is permanent.
Timing	Considers when the residual environmental effect is expected to occur. Timing considerations should be noted in the evaluation of the residual environmental effect, where applicable or relevant.	**Not Applicable** – seasonal aspects are unlikely to alter the residual environmental effect on the marine environment. **Applicable** – seasonal aspects may alter the residual environmental effect on the marine environment.

Table 7.2 Characterization of Residual Environmental Effects on the Marine Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the Project activity ceases	**Reversible** – the residual environmental effect is likely to be reversed after activity completion and reclamation. **Irreversible** – the residual environmental effect is unlikely to be reversed.
Ecological and Socioeconomic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – the area is relatively undisturbed or not adversely affected by human activity. **Disturbed** – the area has been substantially previously disturbed by human development or human development is still present.

7.5 EXISTING CONDITIONS FOR THE MARINE ENVIRONMENT

7.5.1 Approach and 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; publicly available reports from marine groups; and government sources (e.g., DFO).

Although the review of previous studies and existing information provided some information on the marine environment in the Project location (e.g., CSR 2017), and specifically at the regional and local spatial scales, it was determined additional information and data were required to support the Project assessment (e.g., benthic habitat, water quality, and sediment quality). In particular, sediment quality and benthic habitat data were required at the location of the submarine cables. Field studies were undertaken in spring 2017 to supplement the existing marine data.

7.5.1.1 Data Collection Methods

A field program was conducted by Stantec in spring 2017 to characterize the marine environment within the area of the proposed submarine cables. During the consultation process, local fishers identified a more preferential route. A geophysical survey was conducted on this revised route prior to NB Power accepting the proposed changes. This original route is located within 250 m from the proposed route within Head Harbour Passage and within 1,000 m of the initial proposed route within the Grand Manan Channel. Additional biophysical field data were not collected along the revised route or where the existing submarine cables will be decommissioned, therefore inferences were made based on the 2017 data collected along the original route. Data collection methods for each program are briefly summarized below.

Bathymetry

Bathymetric data were obtained from the review of previous studies and existing information. This was supplemented with bathymetric data collected by Canadian Seabed Research (CSR) during the geophysical survey of the submarine cable areas (CSR 2017). The bathymetric survey was first undertaken by CSR from September 16 to October 5, 2016 for both Head Harbour Passage and the Grand Manan Channel. Following changes to the cable route in the Grand Manan Channel in 2017, CSR undertook a second bathymetric survey of the Grand Manan Channel from September 30 to October 5, 2017 for the revised route and included, among other tasks, the mapping of the seafloor using multi-beam echo sounding and side-scan sonar imaging. Bathymetry data were collected using a Teledyne-Reson SeaBat T20-P Multibeam Echosounder, and a Klein 3000 dual frequency side-scan sonar system was used to capture the seabed imaging component.

Surficial Geology and Sediment Characteristics

The Stantec 2017 field program included the collection of 14 sediment grab samples from the seafloor at different locations along the initial submarine cables route (Figures 7.3 and 7.4). Water quality profiles, described further below, were also collected at the same locations as the sediment samples. All sediment samples were collected on May 31 and June 1, 2017 using a sediment grab sampler. A composite sediment sample was taken from a minimum of two grabs, or up to a maximum of five partial grabs depending on site conditions. Large rocks, shells and debris were removed from the sample before placing the sediment in sample containers. The composite sediment sample was divided into clean laboratory supplied sample containers, and immediately placed in a cooler for submission to the laboratory. A visual inspection of the sediment was conducted and recorded, which included texture and grain size, and a picture of each sample inside the grab was taken. The equipment used to collect the sediment samples was cleaned and rinsed with sea water between sampling locations. The sediment samples were delivered to the analytical laboratory, Maxxam Analytics in Dartmouth, NS, within 72 hours of sampling activities. Lab duplicates were included in the analysis for laboratory quality assurance and quality control (QA/QC) purposes.

Wind and Waves

Metocean conditions for the area of the Project were summarized using existing MSC50 hindcast data. The approach to hindcast data consists of the application of numerical wind and wave models together with historical meteorological data to simulate the evolution of surface winds and ocean wave response in the region of interest. Hourly wind and wave time-series data were obtained from the MSC50 hindcast model available from DFO and Environment and Climate Change Canada (ECCC).

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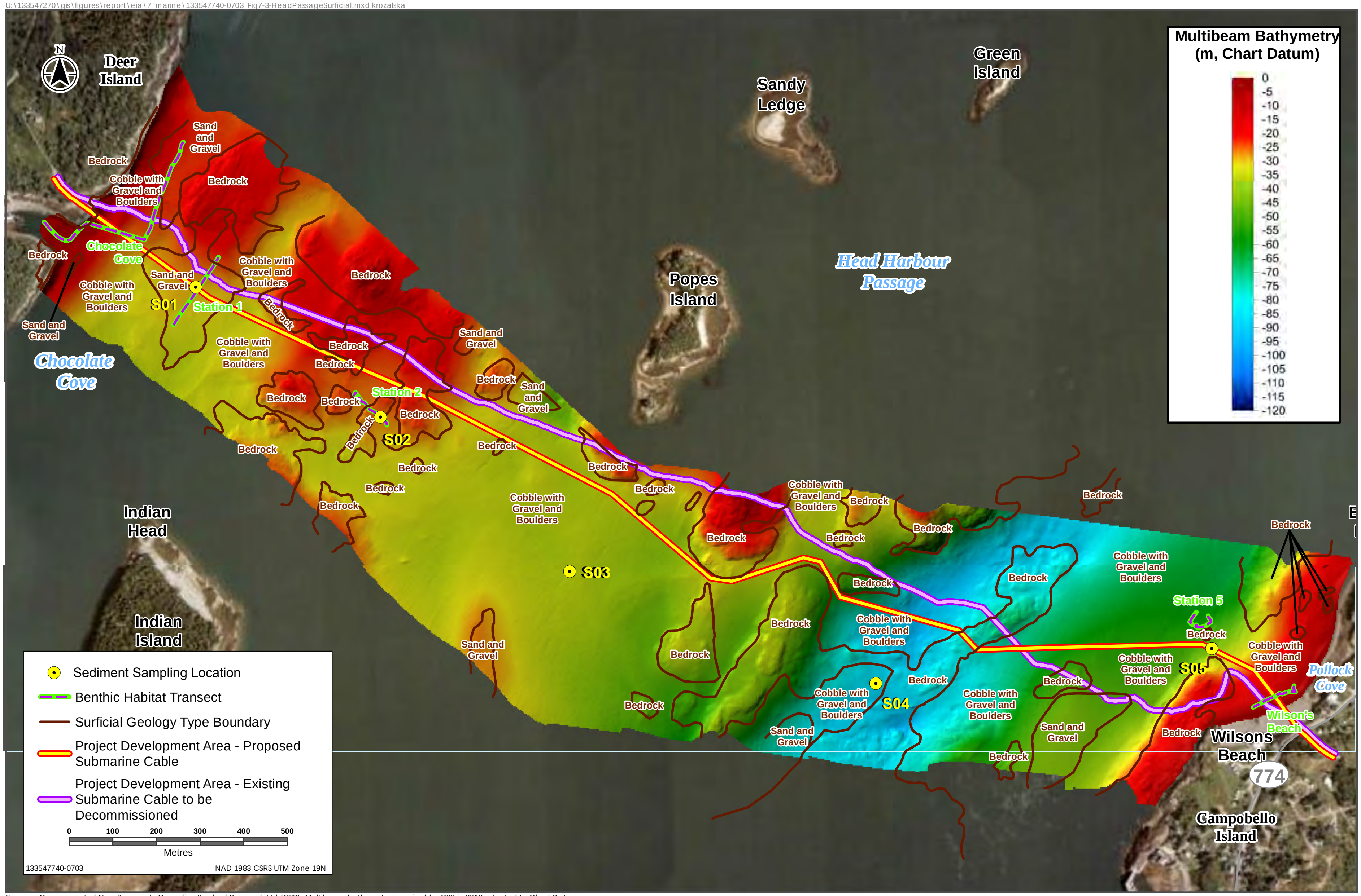

Sources: Government of New Brunswick, Canadian Seabed Research Ltd (CSR). Multibeam bathymetry acquired by CSR in 2016 adjusted to Chart Datum.

Marine Sampling Locations and Surficial Geology – Head Harbour Passage

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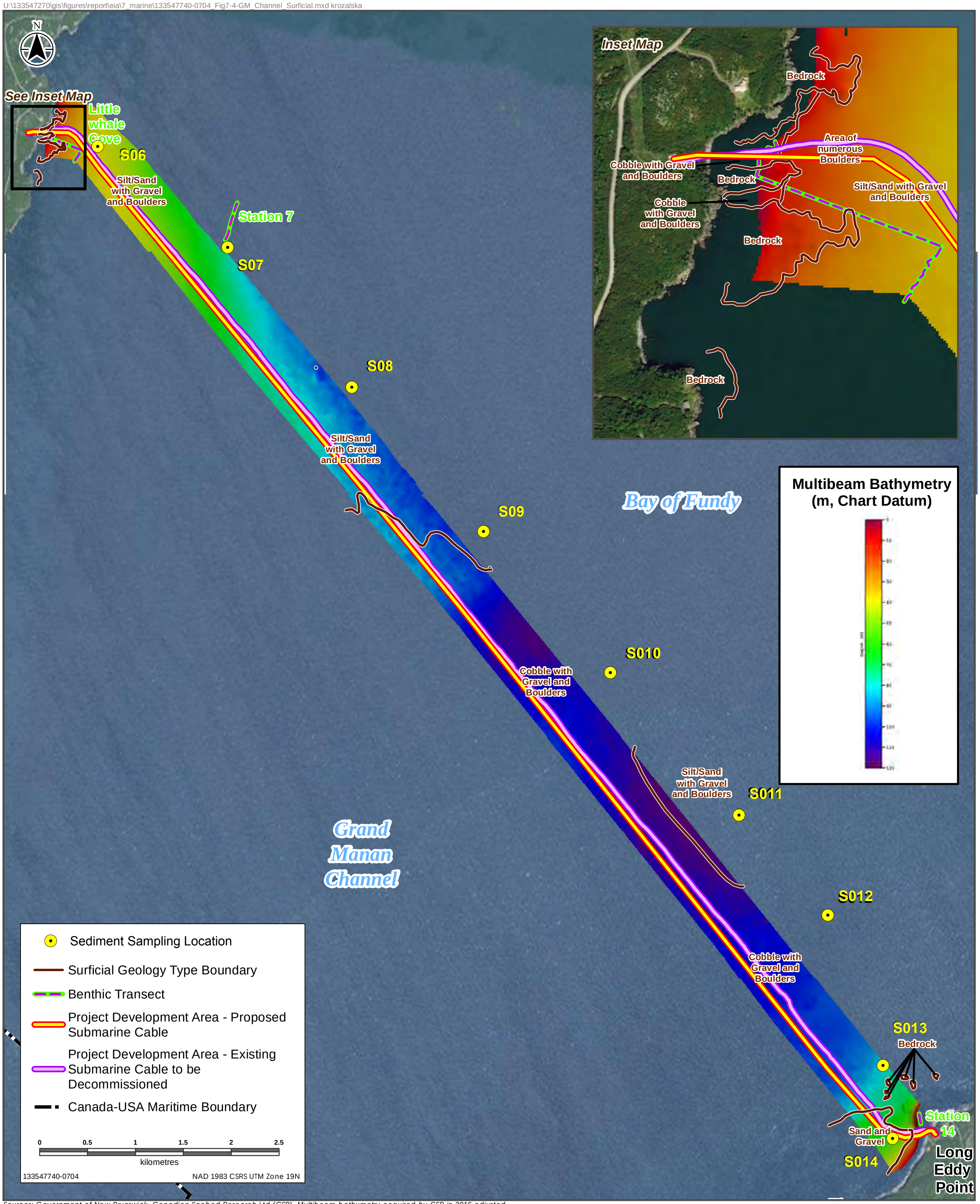
133547740 - FUNDY ISLES - NB POWER

Figure 7.3



Sources: Government of New Brunswick, Canadian Seabed Research Ltd (CSR). Multibeam bathymetry acquired by CSR in 2016 adjusted to Chart Datum.
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Marine Sampling Locations and Surficial Geology – Grand Manan Channel

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Tides

Tidal information for the area of the Project was obtained from the DFO tidal prediction database (CHS 2017) for Wilsons Beach to represent tides for Head Harbour Passage, and for North Head to represent tides for the Grand Manan Channel.

Water Currents

Water current data were collected in Head Harbour Passage and Grand Manan Channel using a 300 kHz RDI-Teledyne acoustic Doppler current profiler (ADCP). Eight ADCP transects were collected along the survey centerline of the Head Harbour Passage route on September 25, 2016; four each during the ebb and flood tides. Five ADCP transects were collected along the survey centerline of the Grand Manan Channel route on October 5, 2016; two transects during flood tide, one at high tide, and two during ebb tide.

The water current data were collected by Canadian Seabed Research during the geophysical survey of the area (CSR 2017).

Water Mass Characteristics

Fourteen stations along the proposed new subsea cables route were selected to represent baseline conditions in the nearshore area. Water quality profiles were conducted during the flood tide on May 31 and June 1, 2017 and the ebb tide on June 1 and June 2, 2017. At each of the 14 stations (Figure 7.3 and Figure 7.4), an in-situ water quality profile was conducted for temperature, conductivity, dissolved oxygen, and turbidity using a YSI 6600 multi-parameter sonde. Calibration of the sonde was completed prior to the field survey, with the dissolved oxygen sensor calibrated daily and immediately prior to use. Due to a failure of the pH sensor in the field during the surveys, pH measurements could not be collected.

Benthic Habitat

Underwater video was collected using a Video Ray Pro 4 remotely operated vehicle (ROV) with a mounted underwater camera system. Locations for the use of the ROV were selected to include the four main surficial substrates identified by CSR (2017). The marine habitat video transects were conducted in each of the surficial substrates, approximately one transect for every kilometre. Additional video was collected nearshore in water depths of approximately 3 to 10 m (see Figures 7.3 and 7.4 for transect locations). Particular attention was placed in the shallow nearshore waters to characterize the benthic habitat around the potential marine exit point for the HDD of the submarine cables.

7.5.2 Description of Existing Conditions

7.5.2.1 Physical Environment

Bathymetry

The Bay of Fundy is a funnel-shaped bay approximately 322 km long, ranging from 5 km to 70 km wide with an average depth of 75 m (CSR 2017). The Bay is located between Nova Scotia and New Brunswick, opening to the Gulf of Maine to the southwest. The Fundy Isles are located at the mouth of the

Bay of Fundy, along the southwestern coast of New Brunswick. The three largest islands include Deer Island, Campobello Island, and Grand Manan Island.

The proposed submarine cables route extends from Deer Island to Campobello Island across Head Harbour Passage, and from Campobello Island to Grand Manan Island across the Grand Manan Channel. This route encompasses a total distance of 17.9 km; 3.4 km within Head Harbour Passage and 14.5 km within the Grand Manan Channel (CSR 2017).

Head Harbour Passage and the “Quoddy River” separate Campobello Island and Deer Island. The Quoddy River is an area within Head Harbour Passage near the southern portion of Deer Island that is so named by local residents because of the unusually high currents there. These two underwater features have distinct bathymetry and are partially separated by a chain of small islands and shoals. The Quoddy River runs parallel to Deer Island and is shallower than Head Harbour Passage; it has an initial steep slope from 0 to 30 m before the grade decreases, remaining constant between 30 and 40 m. The Head Harbour Passage is characterized by a narrow, steep-sided channel paralleling the shoreline of Campobello Island. Depths in excess of 88 m are found in the perpendicular axis of this channel (CSR 2017).

Starting from Campobello Island and moving east, the Grand Manan Channel route is characterized by an initial moderately sloping seabed extending from 0 to 45 m. The Grand Manan Channel bathymetry along the proposed route reaches a maximum depth of 117 m, approximately two-thirds of the way between Campobello and Grand Manan. The approach to Grand Manan shows a very steep slope where the seabed ascends from a depth of 70 m up to 0 m at the shoreline over a distance of approximately 100 m. Additional more detailed bathymetric information is presented in CSR (2017).

Surficial Geology and Sediment Characteristics

Four main substrates were identified in the CSR study (CSR 2017) (Table 7.3). These substrates were selected as per the interpretation of the side-scan sonar and sub-bottom profiler records and correlations with ground truthing data (grab samples).

Table 7.3 Surficial Sediment Types in the LAA

Surficial Sediment Type	Head Harbour Passage		Grand Manan Channel	
	Presence (Linear m)	Presence (%)	Presence (Linear m)	Presence (%)
Silt/Sand with Gravel and Boulders	0	0	2813	24.0
Sand and Gravel	216	6.9	591	5.0
Cobble with Gravel and Boulders	2,747	87.8	8331	71.0
Bedrock	167	5.3	0	0.0
Source: CSR 2017				

Summaries of surficial geology are presented in CSR (2017) based on previous regional studies carried out for Head Harbour Passage and Grand Manan Channel (Fader et al. 1977, Geomarine Associates Ltd. 1976, and Swift et al. 1969 in CSR 2017), and are summarized below.

Silt/Sand with Gravel and Boulders (Post Glacial Sediments)

This substrate was observed only in the Grand Manan Channel. This substrate was present along the route from depths of 90 m to 117m. It is most likely from underlying Scotian Shelf Drift which was mixed by the strong currents within the Grand Manan Channel (CSR 2017). Ratios of silt, sand and coarse gravel vary throughout this substrate.

Sand and Gravel (Post Glacial Sediments)

This substrate was observed in the Grand Manan Channel and Head Harbour Passage in small local deposits. This substrate was present along the route centerline for 0.3 km in Head Harbour Passage at a depth of 27 to 31 m. Local deposits were identified throughout the route in the form of seabed ripples, where currents are strong and the sand/gravel substrate has little clay/silt content resulting in low cohesive strength (CSR 2017).

Cobble with Gravel and Boulders (Glacial Till)

This substrate was the dominant surficial unit mapped in Head Harbour Passage being present along the route centerline. This unit was also observed in the nearshore area of Little Whale Cove and along the route centerline of the Grand Manan Channel (CSR 2017). This cobble substrate with gravel and boulders correlates with Scotian Shelf Drift, a glacial deposit described as poorly sorted cohesive glacial till. This unit contains fragments of pebble to boulder-sized material mixed with sand, silt and clay sediments. In Head Harbour Passage, fine grained sediments were generally absent because of the high currents.

Bedrock

Bedrock was identified at or near the seabed surface in many areas of the proposed new submarine cables route. Sediments that thinly cover the bedrock area composed of silts to gravels with cobbles and boulders, and visually have the appearance of surficial types described above, were also observed. This was noted throughout Head Harbour Passage and the Grand Manan Channel for about 1.0 km along the route. Exposed bedrock at the seabed surface was as common as sediment thinly-covered bedrock, with approximately 1.0 km of the cable route containing exposed bedrock.

Eighteen surficial sediment samples were obtained by CSR in the 2016 survey along the proposed submarine cables route to support the interpretation of the geophysical data. Analysis was conducted in the field and at the office by CSR geologists. The analysis included a sample description, grain size estimates, and sediment ratio estimates. A summary of the grain size estimates for all samples and their location along the submarine cables route are presented in Table 7.4.

Table 7.4 Particle Size Description of Sediment Samples along the Submarine Cables Route

Sample No.	Coordinates		Sample Description
	Easting	Northing	
Quoddy River/Head Harbour Passage			
GS18[A]	660210	4979040	Cobbles, shell fragments, coarse gravel
GS17[A]	660170	4978895	Coarse gravel, cobbles, shell fragments (scallop)
GS16[A]	660456	4978671	Shell fragments, coarse gravel, fine gravel
GS15[A]	661196	4978091	Cobbles, coarse gravel, sand, shell fragments
GS14[A]	661635	4978074	Shell fragments, fine gravel
GS13[A]	662385	4977870	Cobbles, coarse gravel, shell fragments
GS12[A]	662839	4978028	Cobbles, coarse gravel, sand, shell fragments
Grand Manan Channel			
GS11[A]	665877	4973316	Coarse gravel, sand, shell fragments
GS10[B]	665917	4973459	Fine to coarse gravel, shell fragments
GS9[B]	666320	4973053	Silt, medium sand, coarse gravel, shell fragments
GS8[B]	667252	4971806	Medium sand, coarse gravel
GS7[B]	668312	4970531	Coarse gravel, sandy silt, cobble
GS6[B]	669244	4969341	Cobble, coarse gravel, sandy silt
GS5[B]	670547	4967846	Cobble, shell fragments
GS4[B]	672057	4965952	Cobbles, coarse gravel, sandy silt, shell fragments
GS3[B]	672711	4965135	Fine grained sediments (sand, silt), coarse gravel, cobbles
GS2[B]	674323	4963040	Coarse sand, fine gravel, shell fragments
GS1[B]	674625	4962950	Sand with shells

Source: CSR 2017.
[A] = collected in 2016
[B] = collected in 2017

Grain size analysis was performed on samples containing gravel, sand or fines and collected by Stantec in May/June 2017. Sediment grabs were taken at 14 stations, with seven of the stations returning substrate samples which were too large to conduct particle size analysis. These sites generally corresponded with the CSR sites that contained cobbles and coarse gravels. Seven samples contained enough fines for grain size analysis and were collected from the Grand Manan Channel and Head Harbour Passage. The results of the grain size analysis are provided in Table 7.5.

Table 7.5 Particle Size Distribution of Sediment Samples along the Submarine Cables Route

Sample No.	Coordinates		Sample Description			
	Easting	Northing	Gravel %	Sand %	Silt %	Clay %
Quoddy River/Head Harbour Passage						
S03	661200	4978241	84	15	<0.1	0.6
Grand Manan Channel						
S06	666262	4973308	18	69	5.4	7.6
S07	667629	4972254	4.1	70	12	15
S08	668923	4970795	2.4	27	42	28
S09	670302	4969291	30	38	15	17
S10	671600	4967832	24	49	12	14
S12	673842	4965313	25	62	6.4	6.8
Source: Stantec 2017						

The substrate in Head Harbour Passage is primarily cobbles and coarse gravels with interspersed sections of fine gravels and sand. Silt and clay content was low in all the Stantec and CSR samples collected in this area (Tables 7.4 and 7.5). A higher proportion of sand, silt, and clay was observed in the Grand Manan Channel sediments.

Sediment Quality

Of the 14 stations sampled by Stantec (S01 to S14) (Figures 7.3 and 7.4), those samples that contained fine gravels, sand or fines were submitted to an analytical laboratory for the analysis of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), metals, and organic carbon content. There were seven stations where the substrate was predominantly cobbles and coarse gravels; these samples were not submitted to the analytical laboratory. Of the samples submitted, one sample was collected from Head Harbour Passage and contained low silt and clay content; the remaining four samples and sediment from Head Harbour Passage were too coarse for submission. Six of the nine samples from the Grand Manan Channel were submitted for analysis. Higher silt and clay content was observed in the samples near Campobello Island.

The results of the sediment quality analyses are presented in Table 7.6. All samples were below the reportable detection limit (RDL) for PCBs. Most samples were less than the RDL for PAHs with the exception of sample S06 closest to Campobello Island and sample S08 with the highest proportion of silt and clay in the Grand Manan Channel. These samples contained fluorene and pyrene, while location S08 also contained benzo(*b*)fluoranthene. All samples had concentrations of PAHs that were lower by an order or magnitude than the available Canadian Interim Sediment Quality Guidelines (ISQG) for PAHs (Canadian Council of Ministers of the Environment [CCME] 1999).

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 detected in the samples (aluminum, arsenic, barium, chromium, cobalt, copper, iron, lead, lithium, manganese, nickel, rubidium, strontium, uranium, vanadium and zinc) (Table 7.6). ISQGs are available only for arsenic, cadmium, chromium, copper, lead, mercury, and zinc. Only arsenic exceeded the ISQG guideline at stations S08, S09 and S10. Cadmium and mercury, the two metals with *CEPA* Disposal at Sea Sediment Screening Criteria (CEPA 2001)) were not detected in any sediment sample.

Table 7.6 Total Extractable Metals Along Proposed Submarine Cables Route, Sampled May/June 2017

Parameter	RDL	Units	S03	S06	S07	S08	S09	S10	S12	*CEPA* Disposal at Sea Screening Criteria - Lower Level	CCME Sediment Quality Guidelines	
											ISQG[1] Marine	PEL[2] Marine
Aluminum	10	mg/kg	6,600	9,000	12,000	18,000	12,000	11,000	8,200		-	-
Antimony	2	mg/kg	<2	<2	<2	<2	<2	<2	<2		-	-
Arsenic	2	mg/kg	7	5	7	**12**	**8**	**11**	6	-	7.24	41.6
Barium	5	mg/kg	10	20	29	52	35	29	18	-	-	-
Beryllium	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	-	-	-
Bismuth	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	-	-	-
Boron	50	mg/kg	<50	<50	<50	<50	<50	52	<50	-	-	-
Cadmium	0.3	mg/kg	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.6	0.7	4.2
Chromium	2	mg/kg	14	18	22	34	24	24	20	-	52.3	160
Cobalt	1	mg/kg	6	7	9	14	10	10	8	-	-	-
Copper	2	mg/kg	3	6	9	15	10	9	7	-	18.7	108
Iron	50	mg/kg	17,000	19,000	23,000	34,000	25,000	31,000	19,000	-	-	-
Lead	0.5	mg/kg	6.6	8.3	12	20	13	13	9.5	-	30.2	112
Lithium	2	mg/kg	16	19	24	38	24	23	17	-	-	-
Manganese	2	mg/kg	350	300	400	610	540	730	410	-	-	-
Mercury	0.1	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.75	0.13	0.7
Molybdenum	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	-	-	-
Nickel	2	mg/kg	13	14	20	32	21	20	15	-	-	-
Rubidium	2	mg/kg	4	9	14	24	15	17	8	-	-	-
Selenium	1	mg/kg	<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	-	-	-
Strontium	5	mg/kg	370	120	240	71	130	150	330	-	-	-

Table 7.6 Total Extractable Metals Along Proposed Submarine Cables Route, Sampled May/June 2017

Parameter	RDL	Units	S03	S06	S07	S08	S09	S10	S12	*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	0.2	<0.1	0.1	<0.1	-	-	-
Tin	2	mg/kg	<2	<2	<2	<2	<2	<2	<2	-	-	-
Uranium	0.1	mg/kg	0.3	0.6	0.7	1.0	0.6	0.6	0.5	-	-	-
Vanadium	2	mg/kg	23	33	38	51	38	43	30	-	-	-
Zinc	5	mg/kg	39	42	52	77	54	51	62	-	124	271

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

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

Analytes detected at or above RDL are reported here.

A value in **bold** indicates an exceedance of the corresponding guideline levels

Wind and Waves

Extremal analysis of wind and waves within the Bay of Fundy 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 7890 (Latitude 45.0000 N; Longitude 66.8000 W; water depth 48.5 m) is the closest point to Head Harbour Passage within the MSC50 data set. This point is located approximately 12 km to the north of the cable route.

The Grid Point 7528 (Latitude 44.8000 N; Longitude 66.9000 W; water depth 91.4 m) is the closest point to the Grand Manan Channel within the MSC50 data set. This point is located approximately 3 km to the south of the cable route.

Wind and wave statistics for Grid Points 7890 and 7528 are presented in Tables 7.7 and 7.8, respectively. These values were obtained by applying a Generalized Extreme Value (GEV) statistical distribution to the hindcast data (with a total of 59 annual peak records) and included 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 7.7 Significant Wave Height and Wind Speed Near Head Harbour Passage for Cardinal Direction Covering 45 Degree Sectors

Return Period	Head Harbour Passage (MSC50 Data Point 7890)															
	North		Northeast		East		Southeast		South		Southwest		West		Northwest	
	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	1.3	15.7	1.0	15.3	1.0	14.0	1.3	14.8	1.1	15.1	1.6	14.6	2.5	15.9	2.1	15.9
5	1.5	19.0	1.2	18.8	1.2	17.3	1.7	18.1	1.3	18.3	2.2	18.8	3.1	18.7	2.6	18.7
10	1.7	21.6	1.4	21.5	1.4	19.8	1.9	20.5	1.6	20.8	2.6	21.5	3.6	20.8	3.1	20.8
25	2.0	24.9	1.6	25.1	1.6	23.1	2.2	23.7	1.9	24.1	3.2	25.1	4.3	23.7	3.6	23.7
50	2.1	27.5	1.7	27.8	1.7	25.6	2.5	26.2	2.1	26.6	3.7	27.8	4.8	25.8	4.0	25.8
100	2.3	30.0	1.9	30.4	1.9	28.1	2.7	28.6	2.3	29.0	4.2	30.4	5.2	28.0	4.4	28.0

Notes:
Hs – significant wave height towards this cardinal direction
WS – wind speed (m/s) towards this cardinal direction

Table 7.8 Significant Wave Height and Wind Speed Near Grand Manan Channel for Cardinal Direction Covering 45 Degree Sectors

Return Period	Grand Manan Channel (MSC50 Data Point 7528)															
	North		Northeast		East		Southeast		South		Southwest		West		Northwest	
	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	1.6	16.1	1.8	15.6	1.0	14.3	1.0	15.2	1.1	15.2	1.1	15.0	0.9	16.3	1.1	15.9
5	2.0	19.3	2.2	19.3	1.3	17.4	1.2	18.9	1.4	18.0	1.3	17.8	1.1	19.0	1.4	18.6
10	2.4	21.8	2.5	22.1	1.5	19.6	1.3	21.7	1.6	20.2	1.5	20.0	1.2	21.1	1.6	20.7
25	2.8	25.1	2.9	25.7	1.7	22.7	1.5	25.3	1.9	22.9	1.8	22.8	1.4	23.9	1.8	23.4
50	3.1	27.5	3.3	28.5	1.9	25.0	1.7	28.1	2.1	25.1	2.0	24.9	1.6	26.0	2.1	25.4
100	3.5	30.0	3.6	31.3	2.1	27.3	1.8	30.9	2.3	27.2	2.2	27.1	1.7	28.1	2.3	27.5

Notes:
Hs – significant wave height towards this cardinal direction
WS – wind speed (m/s) towards this cardinal direction

Tides

Tidal fluctuations in the Bay of Fundy are some of the largest in the world. The main reason is that the whole Bay of Fundy/Gulf of Maine system has a natural period of oscillation slightly over 13 h, and so is nearly in resonance with the diurnal tidal forcing from the North Atlantic.

The tidal range in the vicinity of the Project is not as great as further north in the Bay of Fundy, with a maximum range of 8.3 m (DFO 2017a). Predictions of times and heights of high and low water as well as associated tidal currents were obtained from tide and current tables published by DFO. Figure 7.5 presents a typical 28-day period to illustrate the temporal changes in tidal heights and tidal current speeds.

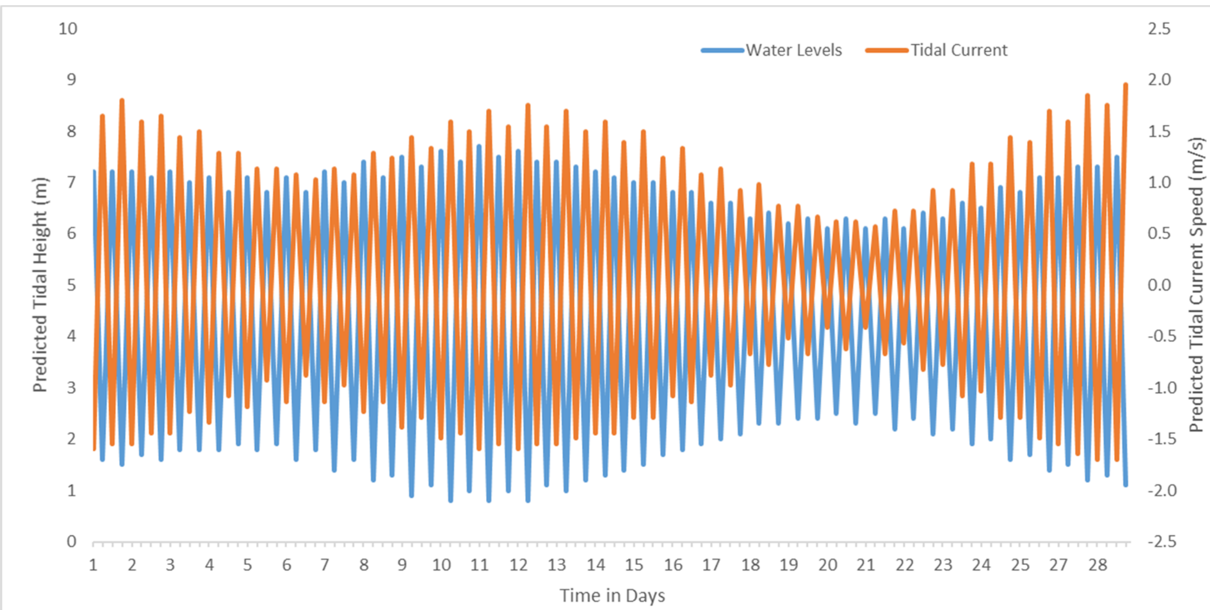
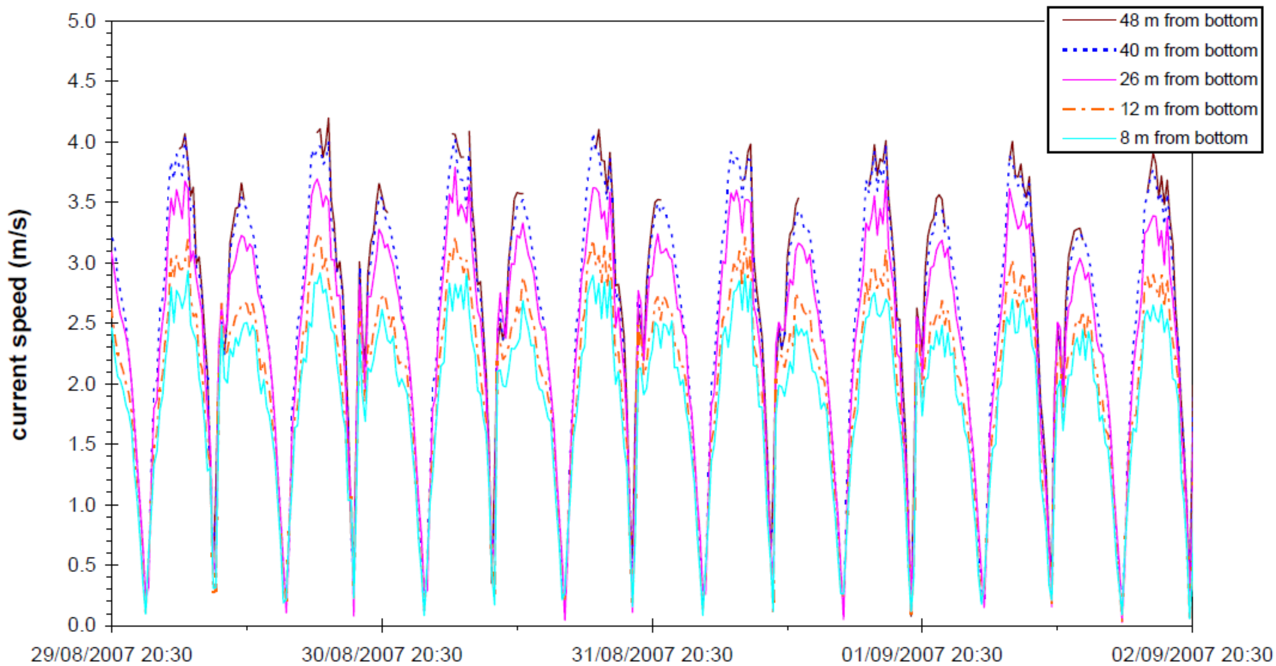


Figure 7.5 Predicted Water Level and Tidal Currents in the Grand Manan Channel

Water Currents

Currents in the Bay of Fundy are mainly driven by tidal effects. In the Grand Manan Channel, the flood currents are in a general north-easterly direction and attain a speed of about 2.0 m/s at strength for an average spring tide, and 1.0 m/s for an average neap tide. The ebb currents are in a south-westerly direction with a speed of about 1.8 m/s at strength for an average spring tide, and 0.75 m/s for an average neap tide (DFO 2017a). Data showing the variability of currents throughout the water column in the Grand Manan Channel can be found in NRCC (2008). These include the results of measurements using an ADCP for a month-long deployment during summer 2007. Figure 7.6 presents the currents by depth over a period of four days during a spring tide.



Source: NRCC (2008)

Figure 7.6 ADCP Mooring Data – Grand Manan Channel (August 29 to September 2, 2007)

Tidal velocity and direction were modelled through Head Harbour Passage as part a 3D assessment of tidal currents (NRCC 2008). The simulations determined the flood currents flow northwards through Head Harbour Passage with a depth-averaged speed of 1.1 m/s for an average spring tide and 0.6 m/s for an average neap tide. The ebb currents reverse in direction with a depth-averaged speed of 1.4 m/s and 0.8 m/s for the spring and neap tides, respectively (NRCC 2008). These modelled results for Head Harbour Passage along with the measured currents in Grand Manan Channel present a general overview of mean current speeds and directions.

Additional ADCP data were collected specifically within the LAA for the Project. CSR conducted ADCP transects using a vessel-mounted 300 kHz ADCP. Measurements were collected in the Passage and Channel on September 25 and October 8, 2016 at flood and ebb tides. Figures 7.7 to 7.10 are representative of conditions observed at that time and illustrate the full water column plots of current magnitude speed (m/s) with depth (top panel) and current direction (degrees true north) with depth (bottom panel) for the Grand Manan Channel and Head Harbour Passage.

During the flooding tide, current velocities and direction in the Grand Manan Channel were uniform throughout the majority of the transect. Currents flowed towards the northeast with the highest velocities (1.5 m/s to 2.0 m/s) measured off Long Eddy Point. Similarly, during the ebbing tide, velocities peaked (1.5 m/s to 2.0 m/s) off Long Eddy Point, though the currents flowed in a southwest direction.

Currents in Head Harbour Passage were typically slower and oriented along the Passage from northeast to southwest during ebbing tides, which reversed during flooding tides. The strongest currents (1.0 m/s to 1.5 m/s) were measured in the deeper section of Head Harbour Passage and near Deer Island. The center of the transect is marked by low current velocities that occur in the lee of Popes Island, Indian Island, and surrounding shoals.

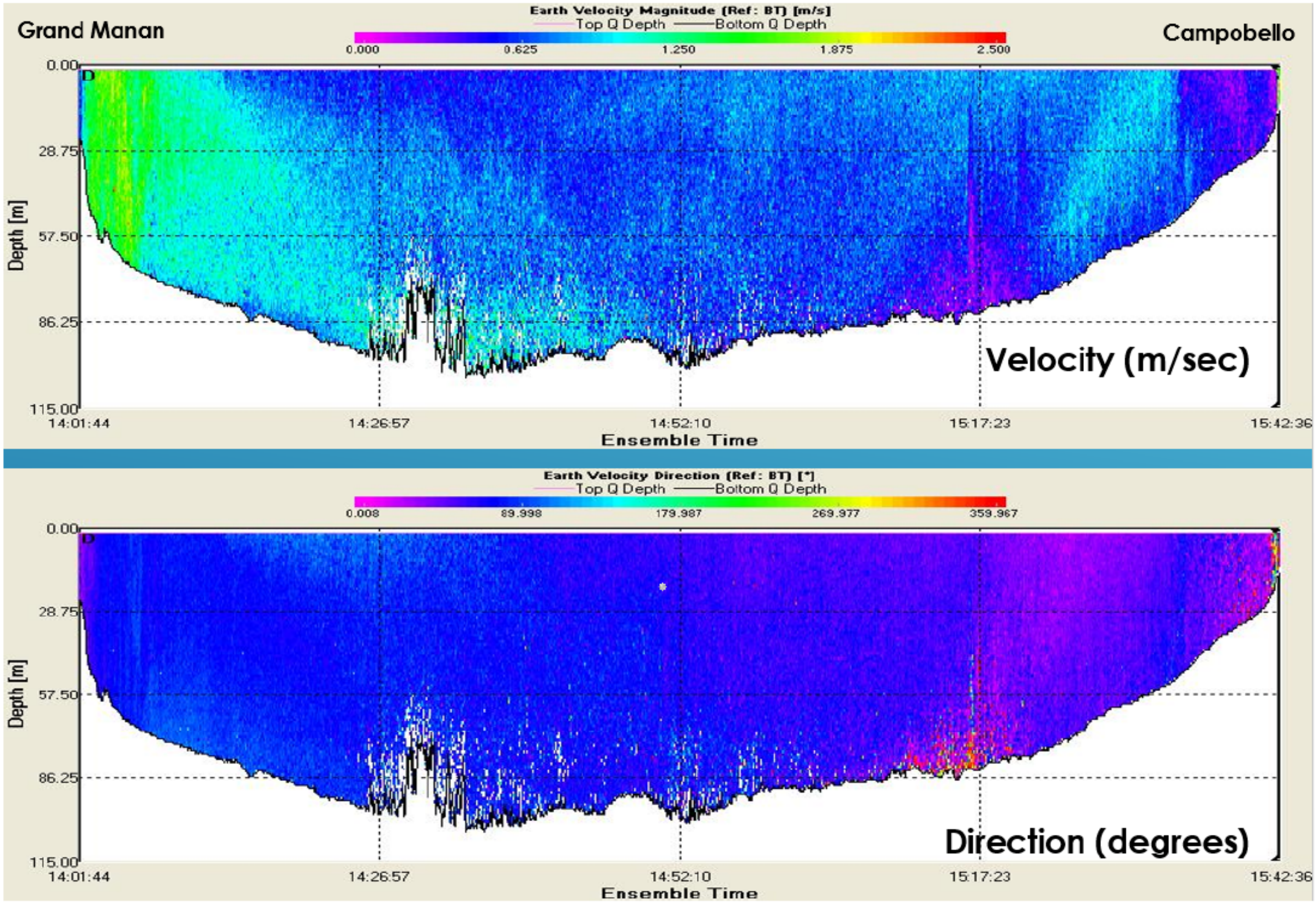


Figure 7.7 ADCP Transect-Grand Manan Channel: Grand Manan Island to Campobello Island (Flood Tide – October 8, 2016)

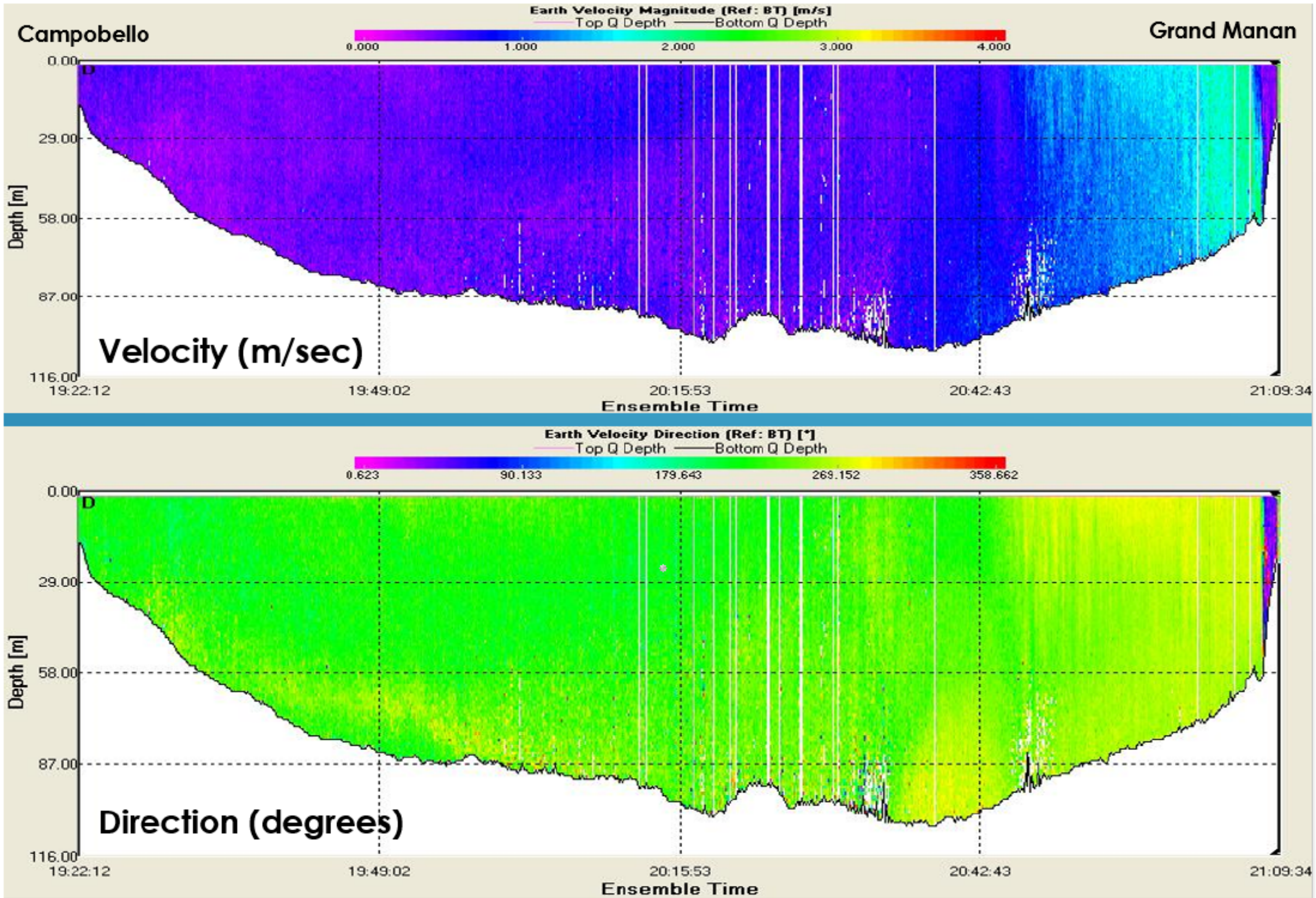


Figure 7.8 **ADCP Transect-Grand Manan Channel: Campobello Island to Grand Manan Island (Ebb Tide – October 8, 2016)**

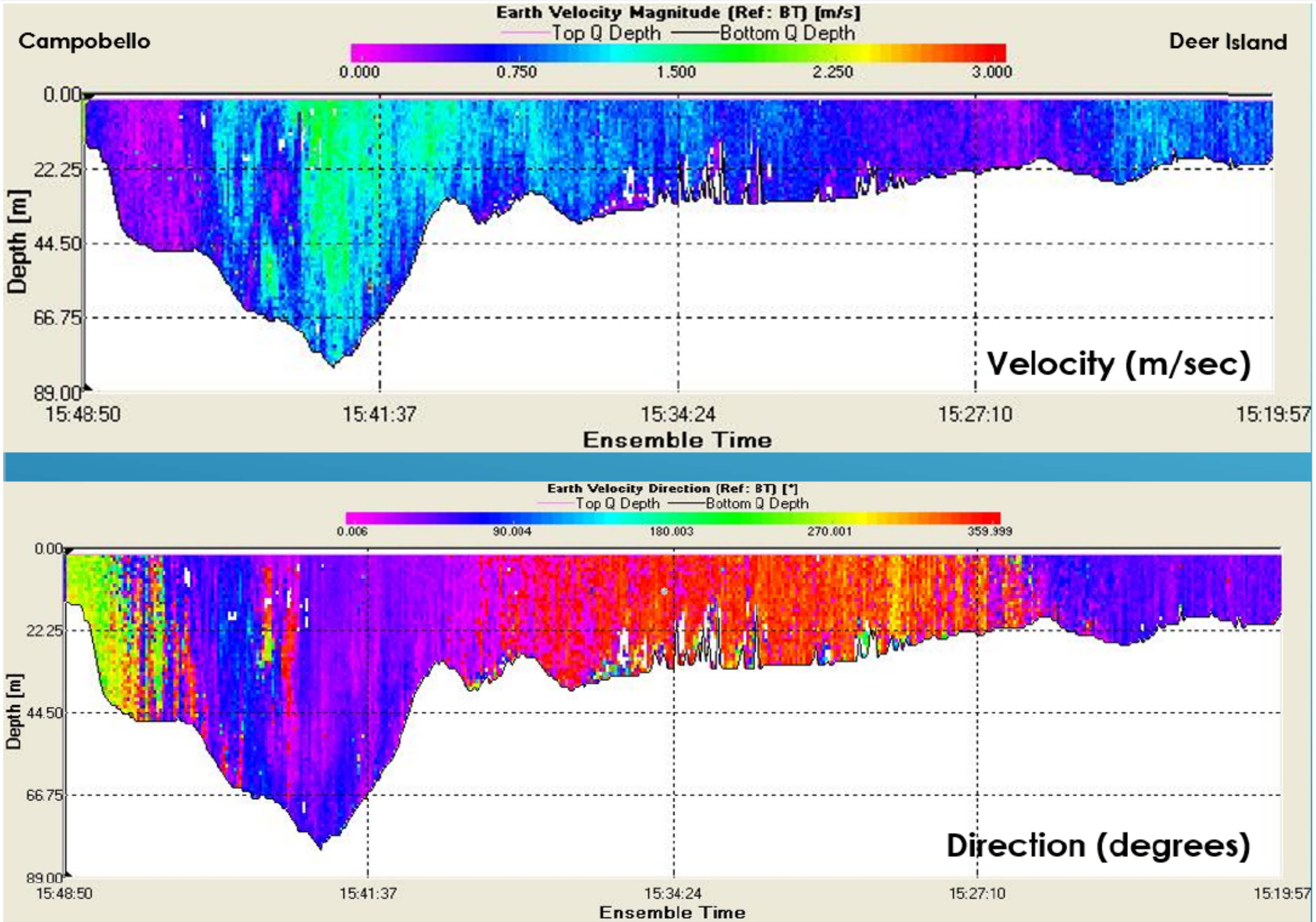


Figure 7.9 ADCP Transect-Head Harbour Passage: Deer Island to Campobello Island (Flood Tide – September 25, 2016)

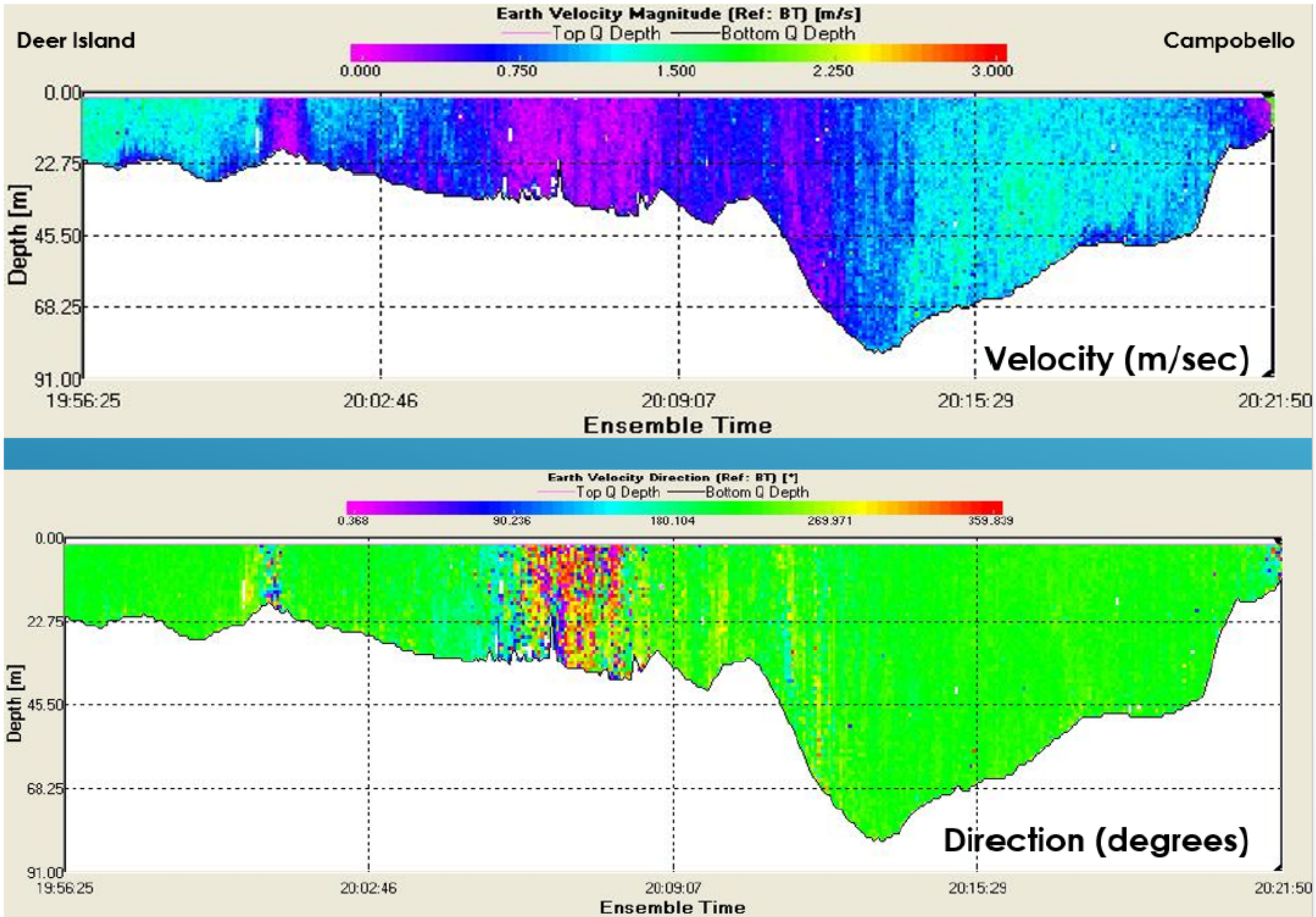


Figure 7.10 ADCP Transect-Head Harbour Passage: Campobello to Deer Island (Ebb Tide – September 25, 2016)

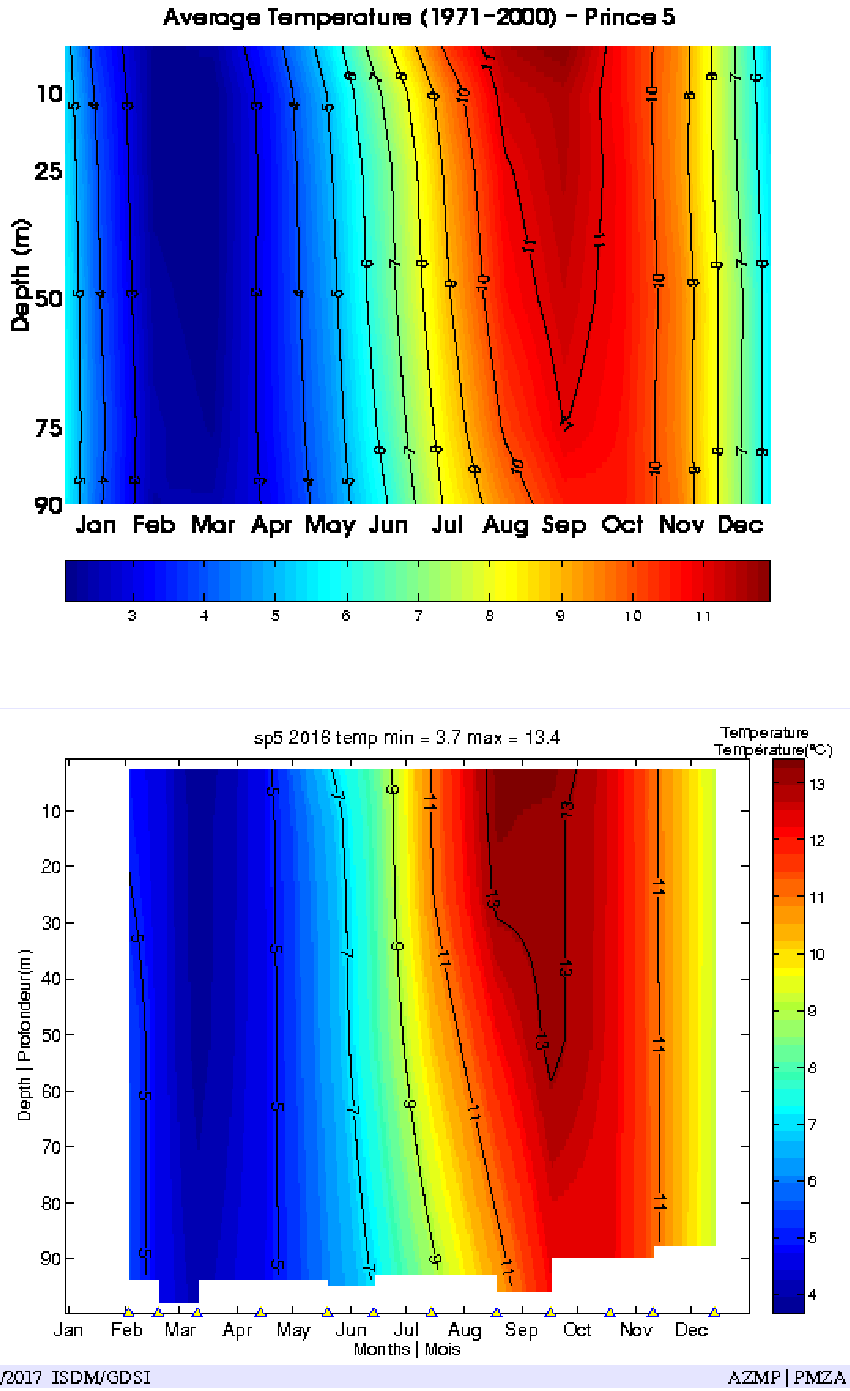
Water Temperature and Salinity

The Atlantic Zone Monitoring Program (AZMP) was implemented in 1998 with the aim of collecting and analyzing the biological, chemical, and physical field data at locations within the Gulf, Maritimes, Atlantic, and Québec DFO Regions. One of the long-term monitoring stations, Prince 5 is located to the northeast of Campobello Island, approximately 5 km from the Project. Data from this monitoring station were used to present seasonal trends in water temperature and salinity.

The average water column temperatures collected at the Prince 5 station are presented in Figure 7.11. Typically, sea temperatures begin to warm with warmer air masses and solar heating in the spring. Maximum temperatures are typically reached by September, reaching 13.4 °C in 2016. In October, the sea temperatures begin to cool and reach minimum temperatures in February and March. In 2016, the minimum temperature was 3.7°C recorded in March (DFO 2017a). Data from Prince 5 shows a well-mixed water column for all months outside of September and October (Figure 7.11). Thermal stratification may occur in these months due to solar heating of surface waters over the summer months.

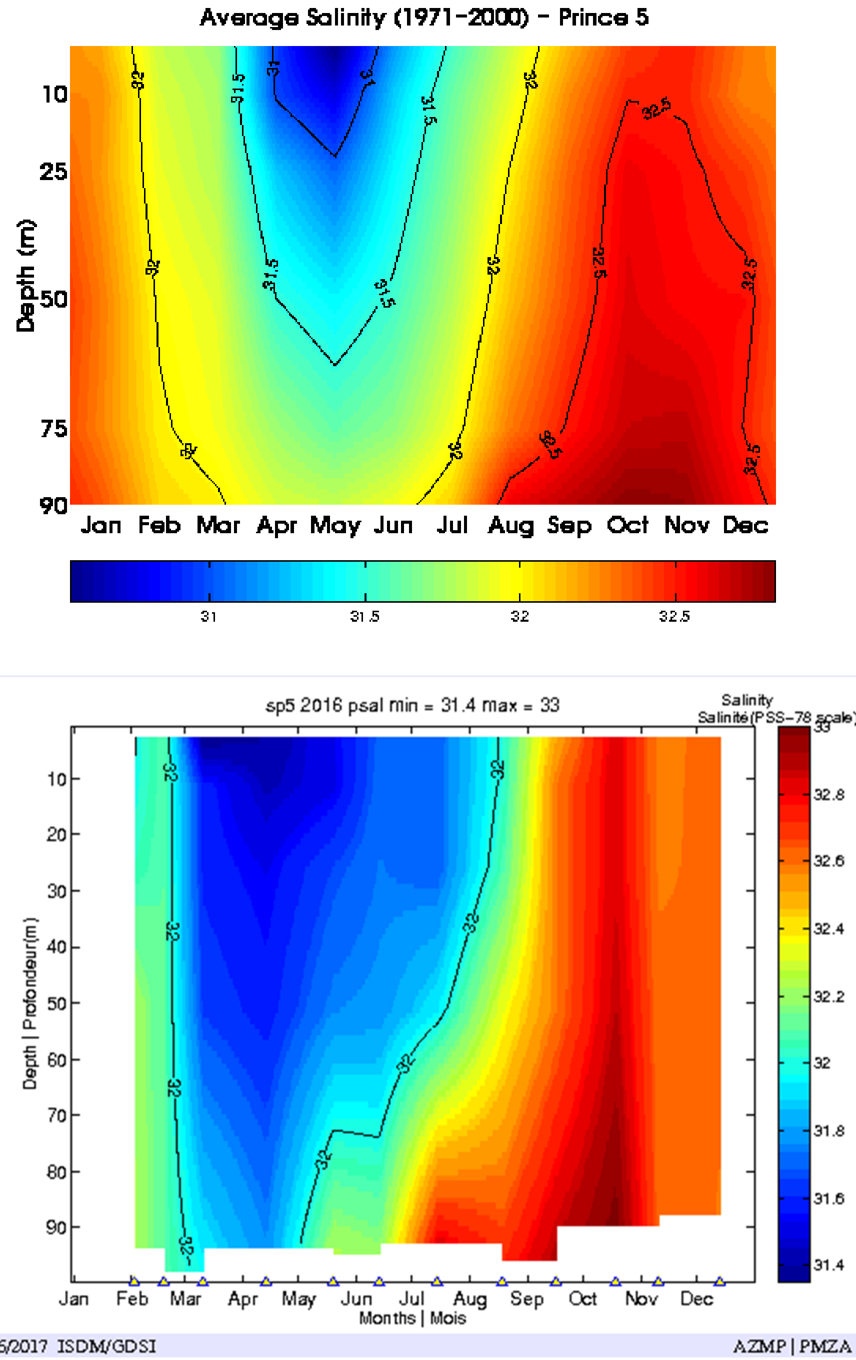
Salinity data from Prince 5 are shown in Figure 7.12. The spring months produce the lowest salinity values in the surface waters, with a salinity of 31.4 practical salinity units (psu) recorded near the surface in March 2016. The highest salinity values are typically observed in the fall near bottom with 33 psu recorded in October 2016.

The warm surface waters in the summer produce the least dense seawater, with the colder deeper waters in fall and winter producing the densest seawater. Data from Prince 5 illustrate the time contour plot of the averages from 1970 to 2000 and the most recent complete dataset for 2016 (Figure 7.13).



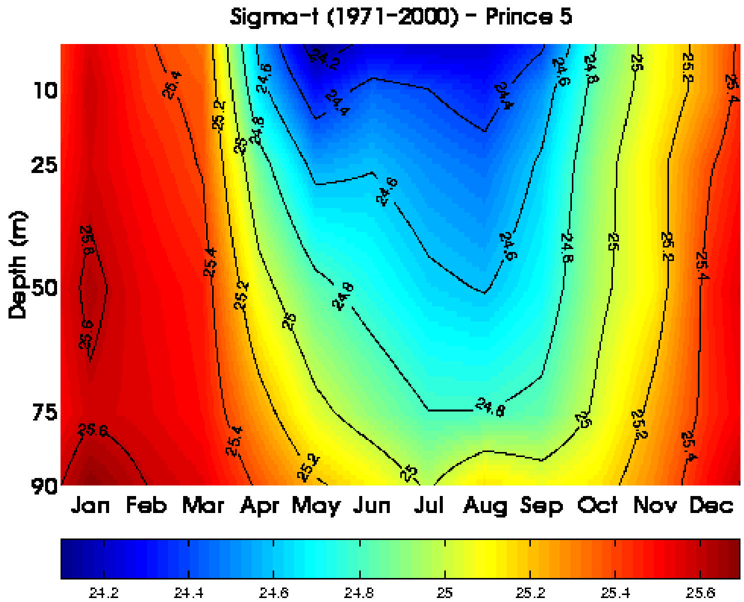
Source: DFO (2017a)

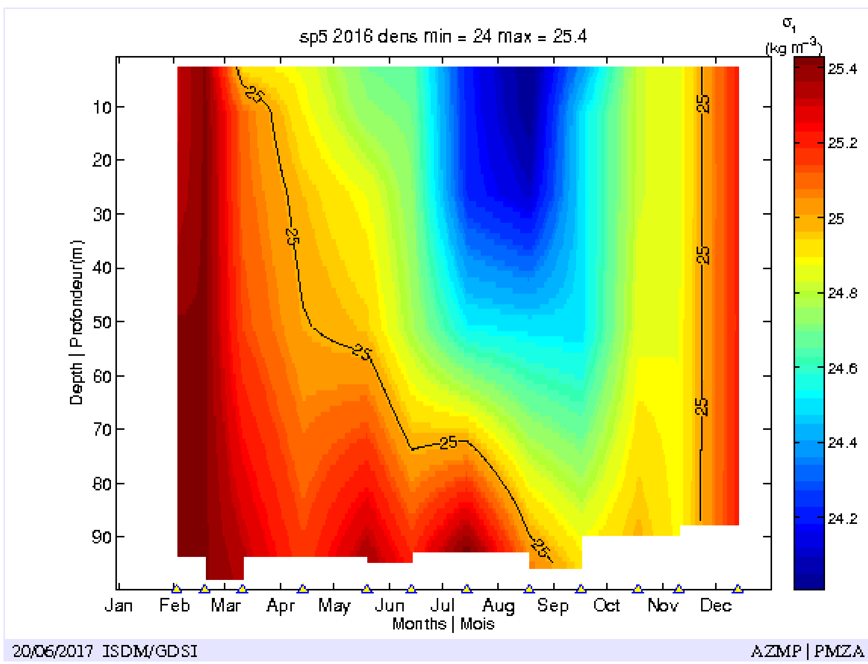
Figure 7.11 Sea Surface Temperature (°C) Climatology 1971 to 2000 (top) and 2016 (bottom) at Station Prince 5, north of Head Harbour Passage



Source: DFO (2017a)

Figure 7.12 Average Salinity (psu) Concentration from 1971 to 2000 (top) and 2016 (bottom) at Station Prince 5, North of Head Harbour Passage





Source: DFO (2017a)

Figure 7.13 Average Density (kg/m^3) from 1971 to 2000 (top) and 2016 (bottom) at Station Prince 5, North of Head Harbour Passage

Water Quality

The water column in the outer Bay of Fundy is well mixed with varying total suspended solids (TSS) concentrations throughout the year; storm events and surface run-off can affect TSS and turbidity levels. Turbidity levels were measured during the field program conducted in May/June 2017 at the stations shown on Figures 7.3 and 7.4. Water quality profiles were conducted on both ebbing and flooding tides. Generally, turbidity values were low at the surface and increased with depth and near bottom. The average near-surface (upper 5 m) turbidity values were 1.1 NTU, and near-bottom turbidity values (5 m above the seabed) were 1.8 NTU. Figures 7.14 and 7.15 illustrate the turbidity profile data collected on ebb and flood tides.

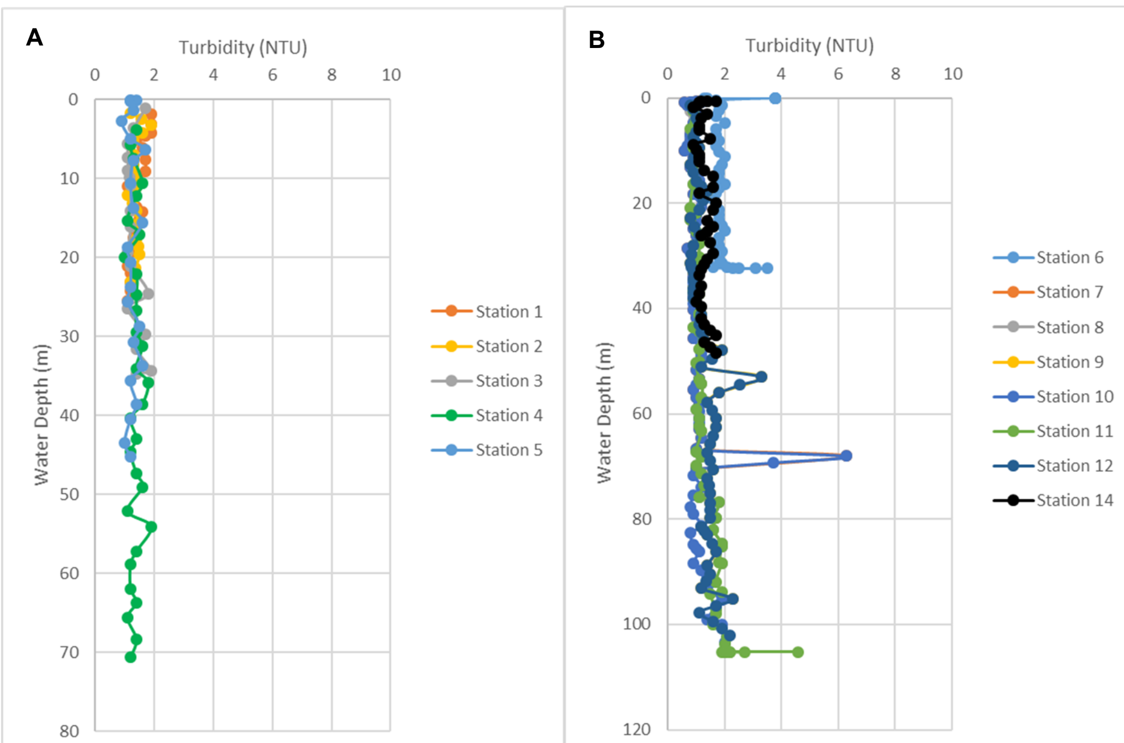


Figure 7.14 Water Quality Profiles for Turbidity during an Ebbing Tide for Head Harbour Passage (A) and Grand Manan Channel (B)

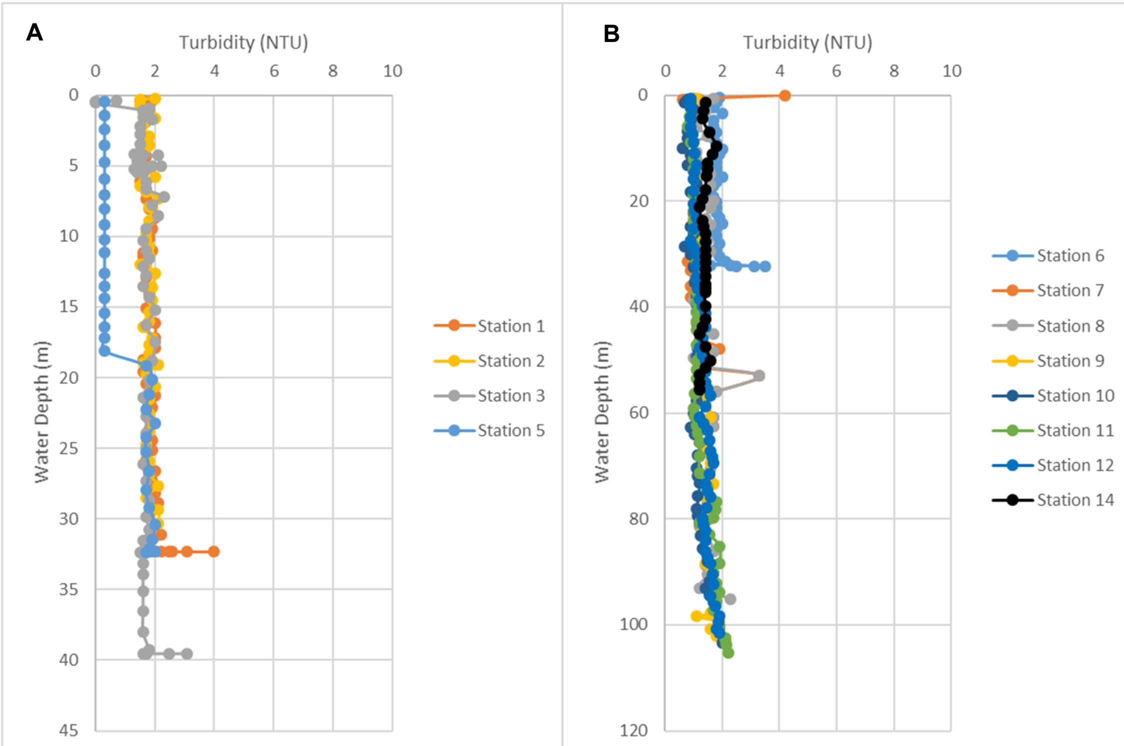
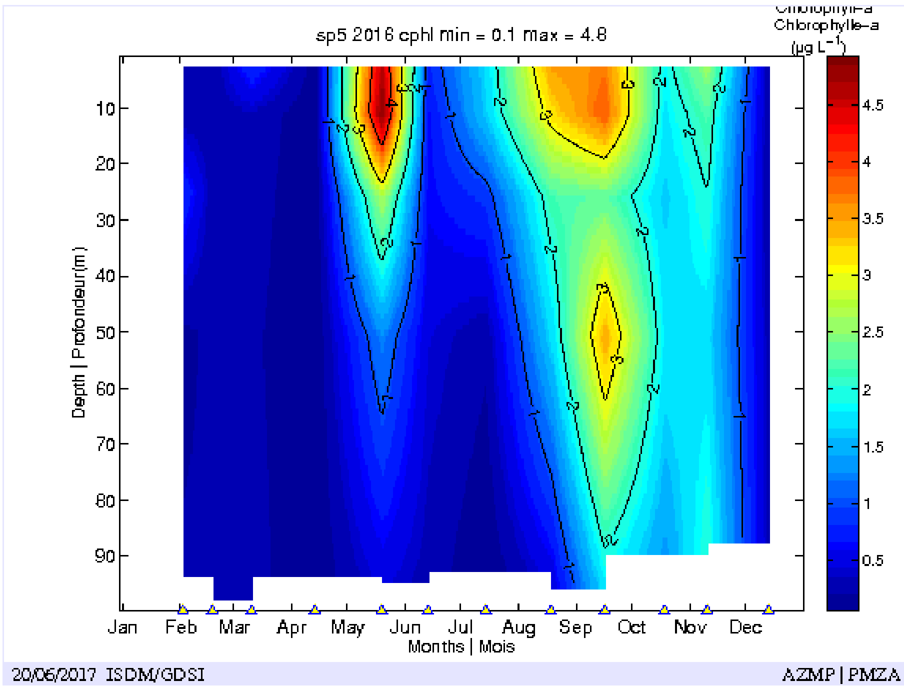


Figure 7.15 Water Quality Profiles for Turbidity during a Flooding Tide for Head Harbour Passage (A) and Grand Manan Channel (B)

Pigment in the water is a good indicator of chlorophyll content. The spatio-temporal distribution of phytoplankton pigments in the Project area can be inferred using chlorophyll *a* data from the Prince 5 station. The concentration of phytoplankton pigments undergoes a seasonal cycle with consistently low values in the fall and winter, and the highest values in the spring and summer (Page et al. 2000). The depth profiles in 2016 indicate the pigments are vertically well mixed during winter and late fall (Figure 7.16).



Source: DFO (2017a)

Figure 7.16 Chlorophyll-a (µg/L) Concentration in 2016 at Station Prince 5, North of Head Harbour Passage.

7.5.3 Marine Habitat

7.5.3.1 Benthic Habitat

As part of the CSR Marine Geophysical Report (CSR 2017), the marine surficial geology along Head Harbour Passage and Grand Manan Channel routes has been divided into four main substrate types that are presented as bolded text below. The surficial geology was mapped according to the geophysical acoustic signature unique to each substrate type. This was accomplished through interpretation of the side-scan sonar and sub-bottom profiler records and correlations with ground truthing samples.

Marine benthic habitat video transects were laid out to capture the variation in surficial geology and substrate types (Figures 7.3 and 7.4). Transects were spaced approximately one every kilometre across Head Harbour Passage and the Grand Manan Channel. Due to water clarity and visibility at the time of the surveys, video suitable for habitat assessment was available from four of these fourteen transects. Additional video was collected in the nearshore environment in water depths between 3 and 10 m. This video was collected to characterize the benthic habitat around the potential marine exit points for the HDD of the submarine cable. The following are brief descriptions of the benthic habitat observed at each station and the cable landfall locations at Chocolate Cove, Wilsons Beach, Little Whale Cove and Long Eddy Point.

Chocolate Cove (Cobble with Gravel and Boulders)

Two transects were conducted in Chocolate Cove. The shallow transect was conducted from west to east from 6 to 12 m water depth. The deeper transect was oriented from south to north at a water depth between 25 and 30 m (Figure 7.3). The substrate was predominantly gravel and cobble with more macroflora observed along the shallow transect. The substrate size increased with depth and coarser material was observed along the deeper transect. Shell fragments were observed throughout the transects. Species observed included scallop (*Placopecten magellanicus*), seastars (*Asterias* sp.), green sea urchins (S*tronglyocentrotus dreobachiensis*), and plumose anenomes (*Metridium* sp.) Urchins and scallop were the most abundant macrofauna observed.

Transect 1 (Sand and Gravel)

This transect was conducted from south to north at a water depth between 43 and 50 m (Figure 7.3). The substrate was predominantly cobble and gravel with little flora and few cobbles. Shell fragments were observed throughout the transect. There was little variance in substrate over the 250-m transect length. Species observed were scallop, seastars, green sea urchins, and an unidentified anemone. Scallop and urchins were the most abundant macrofauna observed.

Transect 2 (Bedrock)

This transect was conducted from east to west at a water depth of 30 m (Figure 7.3). The substrate was predominantly cobble and gravel with little macroflora and few cobbles. Shell fragments were observed throughout the transect. There was little variance in substrate over the 125 m transect. Species observed were scallop, seastars, green sea urchins, and an unidentified white lobed sponge. Scallop and urchins were the most abundant macrofauna observed.

Transect 5 (Cobble with Gravel and Boulders)

This transect was conducted from west to east at a water depth between 50 and 60 m (Figure 7.3). The substrate was predominantly gravel with infrequent patches of cobble. Shell fragments were observed throughout the transect. There was little variance in substrate over the 100-m transect. Species observed were green sea urchins, scallop, frilled anenomes (*Metridium senile*) and seastars. Urchins and scallop were the most abundant macrofauna observed.

Wilsons Beach (Cobble with Gravel and Boulders)

This transect was conducted from north to south at a water depth between 5 and 10 m (Figure 7.3). The substrate was predominantly cobble and gravel with infrequent patches of sea colander (*Agarum cribrosum*). Shell fragments were observed throughout the transect. There was little variance in substrate over the 250-m transect. Species observed were scallop, seastars, green sea urchins, frilled anenomes, and two sculpins (*Myoxocephalus* spp). Scallop and urchins were the most abundant macrofauna observed.

Little Whale Cove (Silt/Sand with Gravel and Boulders)

The transect in Little Whale Cove was conducted from south to north at a water depth between 5 and 15 m (Figure 7.4). The substrate was predominantly cobble and boulder with interspersed gravels. Macroflora were observed occasionally along the two 125 m long transects and included rockweed (*Fucus* spp.) and knotted wrack (*Ascophyllum nodosum*). Species observed were green sea urchins, seastars, snails, mussels, and an unidentified black encrusting sponge. Sea urchins and seastars were the most abundant macrofauna observed.

Transect 6 (Silt/Sand with Gravel and Boulders)

This transect was conducted from south to north at a water depth of 33 to 38 m (Figure 7.4). The substrate was predominantly gravel with no macroflora observed. A few cobble sized rocks were present along the transect. There was little variance in substrate over the 125 m transect. Infrequent observations of scallop were noted.

Transect 7 (Silt/Sand with Gravel and Boulders)

This transect was conducted from south to north at a water depth of 65 to 70 m (Figure 7.4). The substrate was predominantly gravel with no macroflora observed. There was little variance in substrate over the 125 m transect. Infrequent observations of scallop were noted.

Long Eddy Point (Bedrock)

The transect in Long Eddy Point was conducted from south to north at a water depth between 11 and 15 m (Figure 7.4). The substrate was predominantly cobble and boulder with interspersed gravel. Macroflora were common along the 125 m long transect and included broadleaf kelp (*Laminaria* spp.), Irish moss (*Chrondrus crispus*), rockweed, and knotted wrack. Macrofauna species observed were green sea urchins, seastars, snails, mussels, and an unidentified white encrusting sponge. Sea urchins and seastars were the most abundant macrofauna observed.

7.5.3.2 Underwater Acoustic Environment

Many fish species are known to use sound to assist in either locating prey or avoiding predators, as well as for social interactions (Popper 2003). Sound is produced by vibrations or travelling waves, occurring at different frequencies, and sound pressure or intensity is measured on a logarithmic scale (decibels [dB]) (Chapman and Ellis 1998). A mixture of natural and anthropogenic sources make up the sounds present in the marine environment (Richardson et al. 1995).

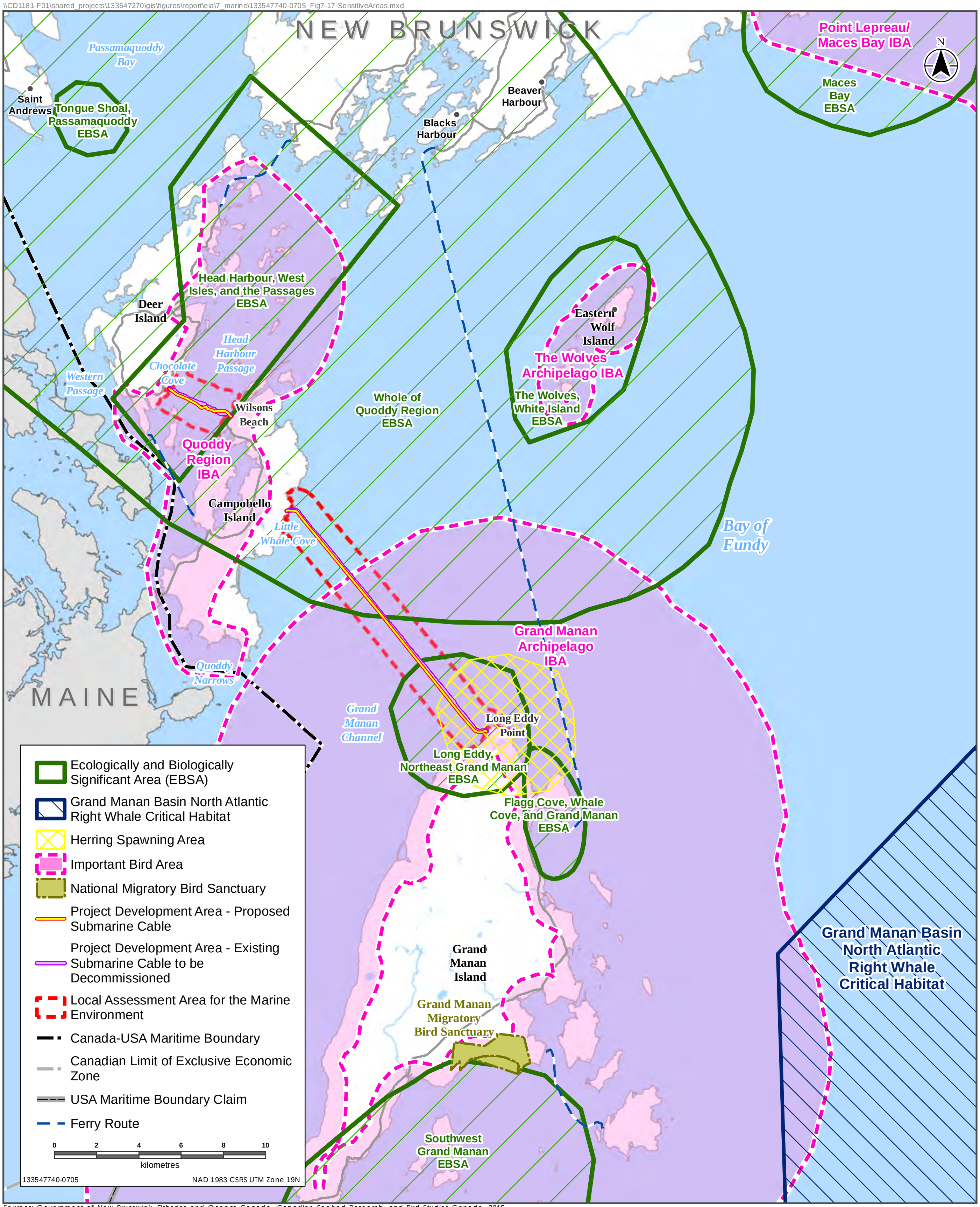
Noise in the LAA currently consists of natural sources such as wind, waves, precipitation, and natural biological noise from marine species, as well as anthropogenic sound sources such as commercial fisheries and shipping. Commercial shipping forms the predominant source of anthropogenic sound in the Bay of Fundy (Desharnais et al. 2000, Hildebrand 2003, Parks et al. 2009). The primary source of noise produced by an operating marine vessel is propeller cavitation (Seol et al. 2002). Vessel noise levels typically increase with vessel size, speed, propeller blade size, number of blades and rotations per minute (Ross 1976, Gray and Greeley 1980, Scrimger and Heitmeyer 1991, Richardson et al. 1995, Hamson 1997). Source levels for individual ships vary from approximately 140 dB re 1 μPa @ 1 m for small fishing vessels to 195 dB re 1 μPa @ 1 m for fast moving tankers (Hildebrand 2003, JASCO Research 2008). Acoustic energy of vessel sound is predominantly concentrated at low frequencies (< 1,000 hertz). Other sources of anthropogenic sound in the Bay of Fundy are construction-related activities (marine- and shore-based), ship-mounted sonars, and acoustic harassment devices.

7.5.3.3 Protected and Sensitive Areas

The locations of protected and sensitive areas near the marine PDA and LAA are shown on Figure 7.17.

Critical Habitat Under *SARA*

The Grand Manan Basin was identified as critical habitat for North Atlantic right whale following a Recovery Potential Assessment conducted for the species in the western North Atlantic in 2007 (Brown et al. 2009). It is the *SARA* critical habitat in closest proximity to the Project, and is located approximately 17 km to the east of the PDA (Figure 7.17). The Grand Manan Basin supports the highest concentrations of copepods in the Bay of Fundy (ibid). The *Recovery Strategy for North Atlantic Right Whale in Atlantic Canadian Waters* provides the following description of the critical habitat area (Brown et al. 2009, pg. 28): "*The edges of Grand Manan Basin lie at about 100 m depth, and the maximum depth of the central Basin is approximately 200 m. The area is exposed to strong tides and the topography and movement of water masses in Grand Manan Basin concentrate the resident copepod population. Every year the Basin area is frequented by a substantial number of the right whales, and in some years up to two thirds of the known population have been sighted in this region. Many females with calves have been sighted in the Bay of Fundy, and a portion of these right whale mothers regularly bring calves to the Bay. Much of the research concerning right whale habitat that has occurred in Canadian waters has been undertaken in and around Grand Manan Basin.*"



Sources: Government of New Brunswick, Fisheries and Oceans Canada, Canadian Seabed Research, and Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org

Protected and Sensitive Areas

Ecologically and Biologically Significant Areas (EBSAs)

Ecologically and Biologically Significant Areas (EBSAs) are designated by DFO as areas of high ecological or biological significance in the role of a species, habitat feature, community attribute, or area in an ecosystem. Although designating an area as an EBSA does not provide any legal or protected status, DFO considers it a tool for calling attention to the area for risk aversion in management activities (DFO 2005).

DFO is currently developing a Marine Protected Area (MPA) network plan, which will identify priority coastal areas for future protection. EBSAs are currently the focus for identifying the priority areas. The EBSAs that may become MPAs will be decided by science and including public input, other government agencies, Aboriginal groups, and interested stakeholders (DFO 2017b).

Portions of the PDA are located within the following three EBSAs:

- Long Eddy, Northeast Grand Manan;
- Whole of Quoddy Region; and
- Head Harbour, West Isles, and the Passages.

Long Eddy, Northeast Grand Manan EBSA

The Long Eddy, Northeast Grand Manan EBSA is located along the northern tip of Grand Manan Island, within the PDA (Figure 7.17). The area is recognized as an important area for marine mammals and marine birds (Buzeta 2014). Marine mammals, such as North Atlantic right whale, minke whale, fin whale, harbour porpoise, harbour seals, and grey seals are known to congregate in the area. In late summer and early fall, the EBSA is an important feeding area for harbour porpoise, minke whale, and fin whale. The EBSA is known to be an important feeding area for shearwaters in the Bay of Fundy. This area is important for overwintering marine bird species including razor bills, common eider, thick-billed murre, common murre, and dovekie (Buzeta 2014).

Whole of Quoddy Region EBSA

The Quoddy Region EBSA (Figure 7.17) is an ecologically distinct area in the outer Bay of Fundy, and includes Passamaquoddy Bay, the St. Croix River, Deer Island, Campobello Island, The Wolves, and Seeley's Head to the northwestern part of Grand Manan Island (Buzeta 2014). The area is considered unique in the Bay of Fundy with high biodiversity and hydrographic conditions, as a result of the area's geological history. Concentrations of zooplankton in the area are due to tidal currents and upwellings. Atlantic herring, Atlantic mackerel, harbour porpoise, humpback whale, North Atlantic right whale, and a variety of marine birds are attracted to the area to feed on the zooplankton. Estimates of species numbers exceed 2,000, making this region the most biodiverse area in the Bay of Fundy (Buzeta 2014).

Head Harbour Passage, West Isles Archipelago, and the Passages EBSA

This EBSA includes the east side of Deer Island to mainland New Brunswick and runs along the shoreline of the west side of Campobello Island to the coast of Maine (Figure 7.17). Due to turbulence and upwellings caused by strong tidal currents, this area is known for concentrations of plankton and associated wildlife that come to the area to feed (Buzeta 2014). Marine mammals, including the humpback whale, fin whale, and harbour porpoise, frequent the area while feeding. The unique landscape within this EBSA provides many suitable seal haulout areas. This EBSA has the highest diversity of benthic macroinvertebrates in the Bay of Fundy, with a diverse community of sponges, sea cucumbers, and anemones (Buzeta 2014).

Important Bird Areas

Important Bird Areas (IBAs) are discrete areas that support nationally or globally important groups of birds. The IBA program is coordinated by BirdLife International and administered in Canada by the Canadian Nature Federation and Bird Studies Canada (IBA Canada n.d.[a]). The criteria used to identify important habitat are internationally standardized and are based on the presence of threatened species, species with restricted range, habitats holding an assemblage of species restricted to a biome, or a congregation of a significant proportion of a species' population during one or more seasons (Moore and Couturier 2011). IBAs are not legally protected but are often found within areas that have been designated as protected areas by federal or provincial authorities.

Quoddy Region IBA (NB037)

The Quoddy Region IBA encompasses the area from the east side of Deer Island to the west side of Campobello Island and the marine habitat in between (Figure 7.17). This IBA is approximately 130 km^2 and includes both open sea and coastal habitats. The high productivity of the area attracts large numbers of foraging birds. Significant numbers of Bonaparte's gull pass through the IBA during fall migration. The area is also known to host a number of other gull species such as herring gull, great black-backed gull, and black-legged kittiwake (IBA Canada n.d.[b]).

Grand Manan Archipelago IBA (NB011)

The Grand Manan Archipelago IBA includes a 10-km band of open water around the island, the Old Proprietor Shoals, the smaller islands in the archipelago, and a 1 km swath of the coast around Grand Manan Island (Figure 7.17). The habitats include mixed-wood forests, grasslands, marshes, coastline, and open water, and encompasses an area of approximately 1,000 km^2. The IBA hosts significant numbers of overwintering razorbills; approximately one third of the North American population. Other species that have large numbers of individuals that commonly overwinter in the area include purple sandpiper, great black-backed gull, common eider, and harlequin duck. Large numbers of brant are present in late winter and early spring. The archipelago also hosts nationally significant numbers of migrating shorebirds during the fall migration (IBA Canada n.d.[b]).

Migratory Bird Sanctuaries

Two migratory bird sanctuaries (designated under the *Migratory Bird Sanctuary Regulations* pursuant to *MBCA*) are located within the Bay of Fundy (Figure 7.17).

The Grand Manan Island Migratory Bird Sanctuary is located on the southeast coast of Grand Manan Island and serves as an important migration and wintering area for a variety of waterfowl, including American black duck (as many as 750 birds have been recorded), bufflehead, sanderling, Canada goose, ring-necked duck, northern pintail, American wigeon, brant, green-winged teal, ring-necked duck, common wider, great black-backed gulls, herring gulls (ECCC 2017a).

The Machias Seal Island Migratory Bird Sanctuary is located 20 km off the southwestern tip of Grand Manan Island and is one of the most important seabird nesting colonies in the Gulf of Maine. Birds that nest on the island include razorbill (approximately 100 pairs) and one of the most southerly colonies of the Atlantic puffin (over 1000 pairs). The Leach's storm petrel also breeds on the island. Over 100 migrants and incidental visitors have been recorded, including several uncommon and rare species (ECCC 2017b).

Finfish Spawning Areas

Historical finfish (cod, haddock and pollock) spawning have been documented in several areas around the Bay of Fundy, including coastal Nova Scotia from Scots Bay to Lurcher Shoal, coastal New Brunswick from Passamaquoddy Bay to the mouth of Chignecto Bay, and southeast Grand Manan. Scots Bay and the area near Machias Seal Island have been documented as historical spawning sites for herring. In most cases, these historical spawning areas are no longer active (Buzeta et al. 2003).

Coastal spawning areas that have remained active (post-1995), as reported by local fishers, include herring spawning areas north of Grand Manan, southeast of Grand Manan, the shipping lane between Grand Manan and Brier Island, and The Rip (Buzeta et al. 2003). Trinity Ledge and Lurcher Shoals are also recognized as herring spawning areas (Stephenson et al. 1999 and Das 1968, in Buzeta et al. 2003). Remaining haddock spawning areas are generally limited to a small area near Old Proprietor Shoal, southeast of Grand Manan, and along Brier Island (Buzeta et al. 2003). The active spawning area in closest proximity to the Project is the herring spawning area north of Grand Manan, which is crossed by the PDA; its approximate location is shown on Figure 7.17.

7.5.3.4 Marine Fish

The Bay of Fundy is characterized by a wide variety of habitat types. With over 100 fish species present, with many of these species occurring in coastal areas surrounding Grand Manan, Campobello Island, outer Passamaquoddy Bay, and in the mid Bay off Mispec Point.

Fish occurring in the Bay of Fundy include resident species, which complete their entire life cycle in the Bay, and those that enter the Bay only during spawning or feeding migrations. Migrating fish species are mainly from the Scotian Shelf and the Gulf of Maine, but include migrants from as far away as Chesapeake Bay (i.e., striped bass, *Morone saxatilis*), the Sargasso Sea (i.e., American eel, *Angullia rostrata*), and the coast of Labrador (i.e., Atlantic salmon, *Salmo salar*).

Species at Risk and Species of Conservation Concern

Due to the large amount of fish species migrating through the Bay of Fundy, Table 7.9 outlines solely the marine fish SAR found within the Bay of Fundy. Two of these species, the Inner Bay of Fundy Atlantic salmon and white shark, are listed as *endangered* on Schedule 1 of *SARA*, while the spotted wolffish (*Anarhichas minor*) is listed as *threatened*. The remaining 18 species are listed as *threatened*, *endangered*, or *special concern* under NB *SARA* and protected under Schedule A.

Table 7.9 Fish SAR Found Within the Bay of Fundy

Common Name	Scientific Name	Federal *SARA* Schedule 1 Status[1]	COSEWIC Status[1] (Year of Assessment)	NB *SARA*[2] Schedule A Status
Acadian redfish – Atlantic population	*Sebastes fasciatus*	No status	*threatened* (2010)	*threatened*
American eel	*Anguilla rostrata*	No status	*threatened* (2012)	*threatened*
American plaice	*Hippoglossoides platessoides*	No status	*threatened* (2009)	*threatened*
Atlantic bluefin tuna	*Thunnus thynnus*	No status	*endangered* (2011)	*endangered*
Atlantic cod – southern population	*Gadus morhua*	No status	*endangered* (2010)	*endangered*
Atlantic salmon - inner Bay of Fundy	*Salmo salar*	*endangered*	*endangered* (2010)	*endangered*
Atlantic salmon - outer Bay of Fundy	*Salmo salar*	No status	*endangered* (2010)	*endangered*
Atlantic sturgeon – Maritimes population	*Acipenser oxyrinchus*	No status	*threatened* (2011)	*threatened*
Atlantic wolffish	*Anarhichas lupus*	*special concern*	*special concern* (2012)	*special concern*
blue shark	*Prionace glauca*	Not at Risk	Not at Risk	*special concern*
cusk	*Brosme brosme*	No status	*endangered* (2012)	*endangered*
porbeagle shark	*Lamna nasus*	No status	*endangered* (2014)	*endangered*
shortfin mako	*Isurus oxyrinchus*	No status	*threatened* (2009)	*threatened*
shortnose sturgeon	*Acipenser brevirostrum*	*special concern*	*special concern* (2015)	*special concern*
smooth skate	*Malacoraja senta*	No status	*special concern* (2012)	*special concern*
spiny dogfish	*Squalus acanthias*	No status	*special concern* (2010)	*special concern*
spotted wolffish	*Anarhichas minor*	*threatened*	*threatened* (2012)	No status
striped bass (Bay of Fundy population)	*Morone saxatilis*	No status	*endangered* (2012)	*endangered*
thorny skate	*Amblyraja radiata*	No status	*Special Concern* (2012)	*special concern*
white shark - Atlantic population	*Carcharodon carcharias*	*endangered*	*endangered* (2006)	*endangered*
winter skate	Leucoraja ocellata	No status	No status	*special concern*

Notes:
[1] Government of Canada 2017a, 2017b
[2] Government of New Brunswick 2015

Not all 21 marine fish SAR listed in Table 7.9 are described herein; however, Atlantic salmon, white shark, spotted wolffish, and Atlantic wolffish are described below due to their relative importance and/or potential to be found within the LAA. Although not a SAR, basking shark (*Cetorhinus maximus*) is also described below. This species is considered because it is a SOCC (the Atlantic population of basking shark is listed as *special concern* by COSEWIC) that has historically been observed near the LAA.

Atlantic Salmon

Inner Bay of Fundy (iBoF) Atlantic salmon is designated as *endangered* on Schedule 1 of the federal *SARA*. The iBoF population originally used at least 32 to 40 rivers between the Saint John River in New Brunswick and the Gaspereau River in Nova Scotia for spawning and rearing (COSEWIC 2006a). The causes of population decline are not well known, although it has been suggested that effects on the freshwater environment may have been part of the decline in numbers, while marine survival is a limiting factor in population recovery (Government of Canada n.d.[a]). This population is expected to stay within the Bay of Fundy for the marine stage of their cycle (DFO 2010). The critical habitat identified in the COSEWIC Recovery Strategy (DFO 2010) includes 10 watersheds in the inner Bay of Fundy. The nearest identified critical habitat is the Big Salmon River watershed which is located approximately 100 km to the north, in New Brunswick.

The outer Bay of Fundy (oBoF) Atlantic salmon is designated as *endangered* by COSWEIC and listed as protected under the NB *SARA*, but does not yet have legal protection under the federal *SARA.* The oBoF salmon spawn in rivers between the Saint John River and Passamaquoddy Bay and spend anywhere from two to four years in freshwater before migrating to the Atlantic Ocean (Government of Canada n.d.[b]). Salmon return to freshwater to spawn after one to three years, typically to the same river system where they were born. Low survival at sea is understood to be the primary reason for population declines, although reasons for low survival at sea are unknown.

Atlantic Wolffish

The Atlantic wolffish is designated as *special concern* on Schedule 1 of the federal *SARA* and a management plan has been completed for the Atlantic wolffish. The Atlantic wolffish is a large bottom-dwelling predatory fish which primarily inhabits cold, deep waters off the continental shelf (Government of Canada 2017a). They are widely distributed across the North Atlantic, and along the Eastern Coast of Canada their distribution extends from southern Labrador, and as far south as Cape Hatteras, North Carolina (Government of Canada 2017a). They are present on the Scotian Shelf, in the Bay of Fundy, and in the Gulf of Maine and have the potential to be present in the Project area (Kulka et al. 2007).

Spotted Wolffish

The spotted wolffish is designated as *threatened* on Schedule 1 of the federal SARA. A recovery strategy has been completed for the spotted wolffish. It is a large predatory, bottom-dwelling marine fish which occurs in cold waters on the open continental shelf and its slopes (Government of Canada 2017a). It is distributed in the western North Atlantic from the Gulf of Maine to the Davis Strait (Kulka et al. 2007). In the western North Atlantic, it occurs primarily off northeast Newfoundland and are considered uncommon or rare on the Scotian Shelf and Gulf of Maine (Kulka et al. 2007).

White Shark

The Atlantic population of the white shark is designated as *endangered* on Schedule 1 of the federal *SARA*, and a recovery strategy for this species has not been released. The white shark is widely distributed from sub-polar to tropical seas in both hemispheres; however, it is most frequently observed and captured in the inshore waters over the continental shelves (Government of Canada 2017a). The white shark occurs in both inshore and offshore waters. The white shark has been recorded in Passamaquoddy Bay and in the Bay of Fundy. Their abundance in Canada is much lower than the adjacent southern United States waters. This species is extremely mobile and individuals found in Atlantic Canada are most likely seasonal migrants belonging to an extensive Northwest Atlantic population (Government of Canada 2017a).

Basking Shark

Basking sharks are believed to have a life span of 50 years, with males maturing between 12 to 16 years of age and females maturing between 16 to 20 years of age (COSEWIC 2009a). Males and females pair up in the summer, presumably to mate. Females have a gestation period of 2.6 to 3.5 years and give birth to about six pups with an average length at birth of 1.5 to 2 m. The species feeds on zooplankton that congregate in oceanic fronts.

They can be found throughout the North Atlantic with concentrations in coastal waters of Newfoundland and near the mouth of the Bay of Fundy. Observations have also been recorded on Georges Bank, the Northeast Channel, and the LaHave and Emerald Banks. Some sightings have also shown the species on Sable Island Bank and over the slope. Basking sharks are frequently seen during summer months, particularly the LaHave and Emerald Basins, where they may mate. They are rarely seen in other seasons but are believed to be found on the Scotian slope at great depths during the winter. There is limited information regarding population sizes and trends, with total population estimates for Atlantic Canada ranging from a conservative estimate of 4,918 individuals to 10,125 individuals (COSEWIC 2009a).

Habitat requirements have not been investigated in Canada, but it is believed that the basking shark lives primarily in oceanic front locations where their main food source, zooplankton, congregates (COSEWIC 2009a). Tagging studies have shown the species occupying surface waters to depths of over 1,200 m.

Figure 7.19 shows the locations of historical basking shark observations recorded by the AC CDC near the LAA.

Commercial, Recreational, and Aboriginal Fisheries

Many marine fish species targeted as CRA fisheries occur in the LAA. The main CRA fisheries are American lobster (*Homarus americanus*), deep-sea scallop (*Placopecten magellanicus*), Atlantic herring (*Clupea harengus*), groundfish, and to a lesser extent, crab. There are no commercial aquaculture operations within the LAA, though several such operations exist off the coast of Blacks Harbour as well as along the eastern shore of Grand Manan.

A brief description of the dominant CRA fishery species in the 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 2013c). Female lobsters 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 2013c). 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 (such as periwinkle), bivalves (such as mussel), crustaceans (rock crab are an important prey item), polychaetes, seastars, sea urchins, fish and plant material (DFO 2009a; DFO 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 lobsters 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.

Atlantic Herring

Atlantic herring are small, silver fish, growing up to 44 cm in length and weighing up to 750 g (Government of Canada n.d.[c]). They feed on plankton, small fish, and larvae. Adult fish remain in deeper water during the day and surface to feed at night. Marine mammals and larger fish species feed on herring and as they are one of the most abundant fish species in the world, they are an important part of the food chain.

Herring spawning grounds typically have pebbly, rocky, or gravelly substrate and are associated with strong currents and mixing (Das 1968, in Buzeta et al. 2003). The timing of spawning migration of herring is related to water temperature. Spawning off of Grand Manan Island (Figure 7.17) typically occurs between July and November (Reid et al. 1999). The eggs are randomly broadcast and adhere to benthic materials (e.g., vegetation and substrate) for a short period of time. The eggs typically take 10 to 15 days to hatch, depending on water temperatures.

Deep-sea Scallop

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

Deep-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).

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), 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 scallops are fed upon by lobsters, rock crabs, seastars, moon snails, burrowing anemones, and fish such as cod, plaice, wolffish, sculpins, and winter flounder (Christian et al. 2010).

7.5.3.5 Marine Wildlife

As discussed in more detail in Section 6.5.2, wildlife field surveys focusing on breeding birds in the terrestrial environment were conducted at the landfall sites by Stantec avian biologists on June 10, 2016 (Long Eddy Point) and June 28, 2016 (Chocolate Cove, Wilsons Beach, and Little Whale Cove). Incidental observations of other wildlife species, including marine wildlife species, were made over the course of these terrestrial surveys. Supplemental information for wildlife occurring within the LAA and surrounding area were obtained from various data sources, including the AC CDC. Figures 7.18 and 7.19 shows the locations of incidental observations of marine birds and other marine wildlife recorded during the Stantec terrestrial bird surveys, as well as the locations of historical marine wildlife SAR and SOCC observations recorded by the AC CDC near the LAA.

Sea Turtles

Desktop review indicates that the leatherback sea turtle (*Dermochelys coriacea*) has been observed, although rarely, within the Bay of Fundy (Right Whale Consortium 2014; Halpin et al. 2009; James et al. 2006), primarily in the outer Bay, around Lighthouse Cove and Long Island, Nova Scotia. Sightings are considered to be rare overall in the Bay of Fundy since the waters of Atlantic Canada represent the northern reaches of their distribution, which extends to the southeast tip of mainland Newfoundland and Labrador (Halpin et al. 2009; James et al. 2006). Leatherback sea turtles are more frequently sighted on the Scotian Shelf and outer coast of Nova Scotia (James et al. 2006), with high-use areas located in the southeastern Gulf of St. Lawrence and off eastern Cape Breton, the waters east and southeast of

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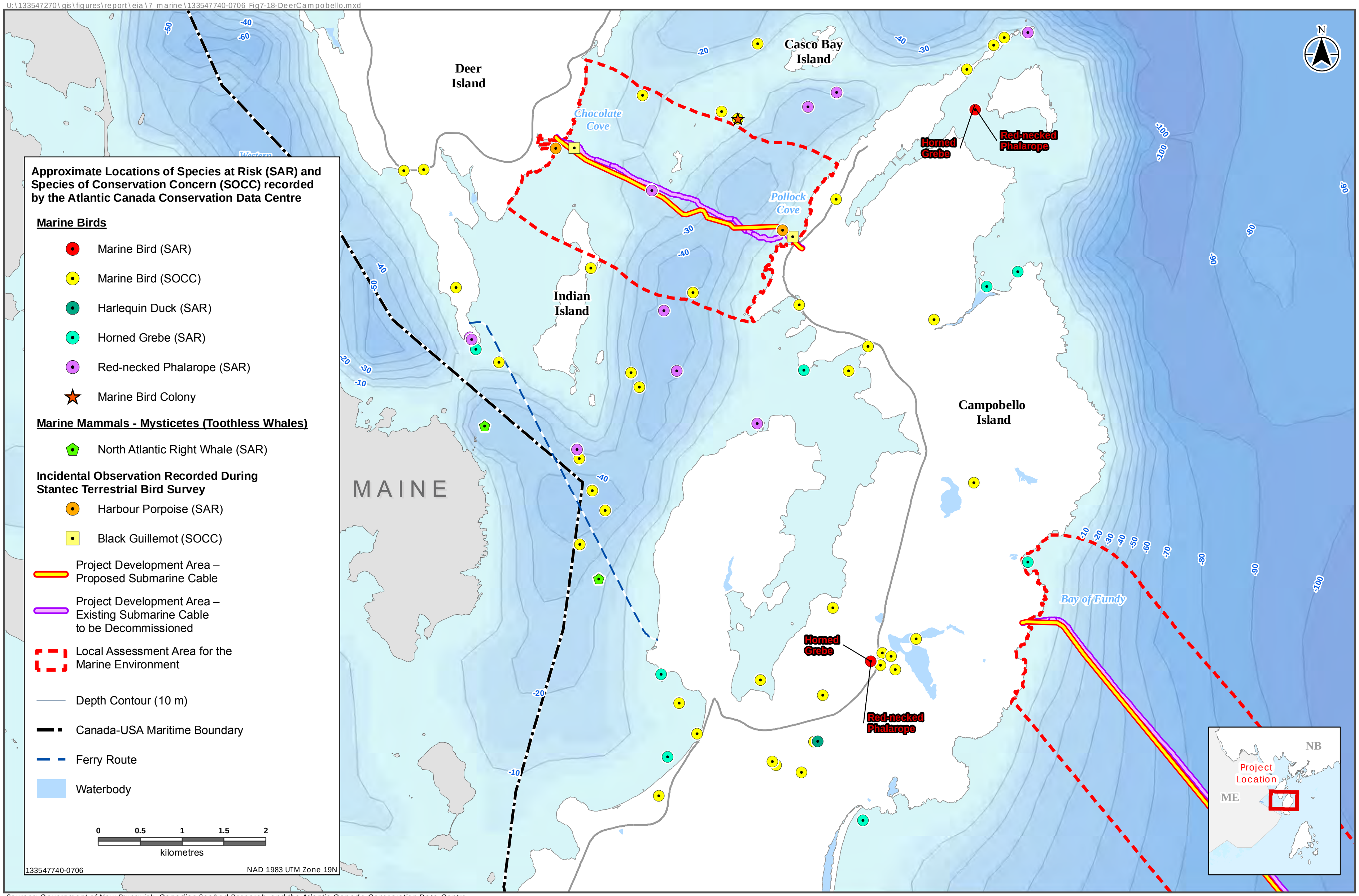


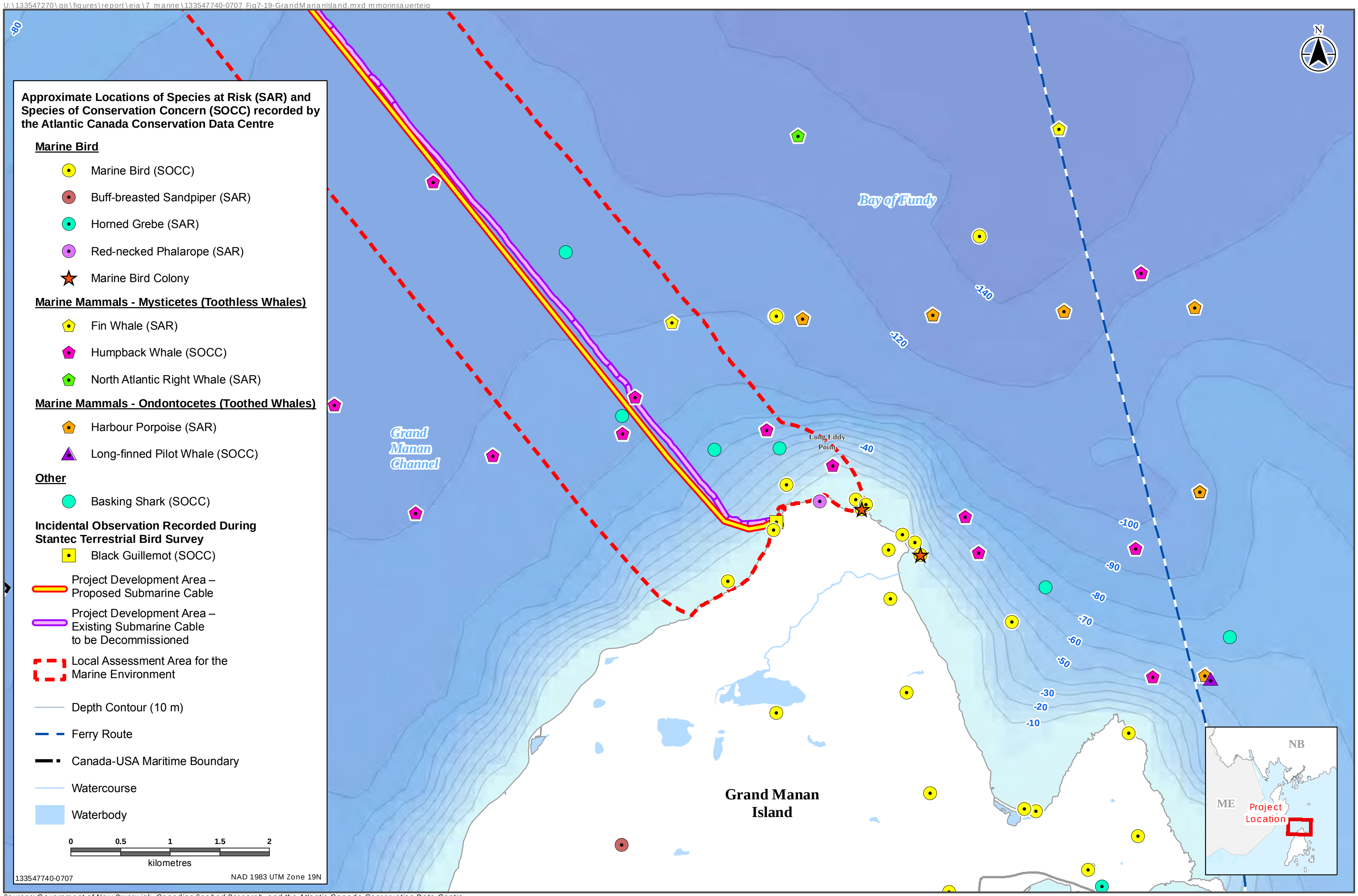
Sources: Government of New Brunswick, Canadian Seabed Research, and the Atlantic Canada Conservation Data Centre.

Marine Wildlife Observations
Deer Island and Campobello Island, New Brunswick

Figure 7.18

Stantec

133547740 - FUNDY ISLES - NB POWER



Sources: Government of New Brunswick, Canadian Seabed Research, and the Atlantic Canada Conservation Data Centre.

Stantec

133547740 - FUNDY ISLES - NB POWER

Marine Wildlife Observations
Grand Manan Island, New Brunswick

Figure 7.19

Georges Bank, and in the waters south and east of Burin Peninsula, Newfoundland (DFO 2012). There is no designated critical habitat for the leatherback sea turtle within the Bay of Fundy.

Marine Mammals

Eight species of marine mammals may be found year-round or seasonally within the Bay of Fundy (Table 7.10). Baleen whale occurrences include: fin whales (*Balaenoptera physalus*), humpback whales (*Megaptera novaeangliae*), minke whales (*Balaenoptera acutorostrata acutorostrata*), and North Atlantic right whales (*Eubalaena glacialis*). Occurrences of toothed whales include Atlantic white-sided dolphins (*Lagenorhynchus acutus*), harbour porpoise (*Phocoena phocoena*), and long-finned pilot whales (*Globicephala melas*). Harbour seals (*Phoca vitulina concolor*) are also frequently observed. The conservation status for each of these species is presented in Table 7.11; fin whale, harbour porpoise, and North Atlantic right whale are all SAR; humpback whale and long-finned pilot whale are SOCC (the latter due to its AC CDC S-rank of S2S3, which is not indicated in Table 7.11); and the remaining marine mammal species are considered secure. All of the marine mammal SAR and SOCC identified in Table 7.11 have been historically observed near the LAA, as recorded by the AC CDC. The locations of these historical observations are shown on Figures 7.18 and 7.19.

Table 7.10 Marine Mammal Species in the Bay of Fundy

Common Name	Scientific Name	Federal *SARA* Schedule 1 Status[1]	COSEWIC Status[2]	NB *SARA* Schedule A Status	Seasonal presence in the Bay of Fundy[4]
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	No status	No status	No status	Year-round
fin whale	*Balaenoptera physalus*	*special concern*	*special concern* (2005)	*special concern*	Year-round
harbour porpoise	*Phocoena phocoena*	No status	*special concern* (2006)	*special concern*	Year-round
harbour seal	*Phoca vitulina concolor*	No status	No status	No status	Year-round
humpback whale	*Megaptera novaeangliae*	No status	Not at risk (2003)	No status	Spring – Fall
long-finned pilot whale	*Globicephala melas*	No status	Not at risk	No status	Spring – Fall[5]
minke whale	*Balaenoptera acutorostrata*	No status	No status	No status	July – September
North Atlantic right whale	*Eubalaena glacialis*	*endangered*	*endangered* (2013)	*endangered*	June – October

Notes:
[1] Government of Canada 2017a
[2] Government of Canada 2017b
[3] AC CDC 2017
[4] Stantec 2016, except where noted otherwise
[5] Waring et al. 2015
– Not applicable

Atlantic white-sided dolphins are found year-round in the Bay of Fundy, but densities in the Gulf of Maine and Bay of Fundy are higher in the summer and lower in the winter when the species move south down the northeastern seaboard of the United States (Northridge et al. 1997). They have been sighted throughout the Bay of Fundy, although concentrated in the lower half of the Bay and have an abundance estimate of 48,819 individuals in 2011 (NOAA 2013a).

Fin whales found in the Canadian North Atlantic are part of two stocks: the Newfoundland/ Labrador stock and the Nova Scotia stock. Members of both stocks are found year-round within the Bay of Fundy, with the Nova Scotia stock moving south during the winter as the northern Newfoundland stock moves into the area (Allen 1971). Fin whales spend most of their time feeding just east of Grand Manan Island (COSEWIC 2005; Gaskin 1983; Woodley and Gaskin 1996), and the distribution in the Bay of Fundy is thought to be limited to the outer Bay (COSEWIC 2005; Ingram et al. 2007). Historical observations of fin whales have been recorded in and around the Grand Manan Channel portion of the LAA (Figure 7.19).

Harbour porpoises are found year-round in the Bay of Fundy. The Gulf of Maine/Bay of Fundy harbour porpoise stock was estimated to have 79,883 individuals in 2011 (NOAA 2013b). The highest densities of harbour porpoises are observed during the summer (July and August) when feeding (Trippel et al. 1999), while densities decrease during the winter as many individuals migrate south to the eastern coast of the

US (NOAA 2013b). Individuals have been observed in the inner Bay of Fundy and along the south and west shores of Nova Scotia, but numbers are much higher in the outer Bay of Fundy (COSEWIC 2006b; Palka 2000). Harbour porpoises were recorded as incidental observations during bird surveys conducted at the landfall sites; four adults were recorded off Chocolate Cove and two adults were recorded off Wilsons Beach. The locations of these incidental observations are shown on Figures 7.18 and 7.19. Harbour porpoises have also been historically observed in the Grand Manan Channel, in and around the LAA (Figure 7.19).

Harbour seals are the only pinniped species commonly found within the Bay of Fundy, and are present year-round, with highest abundances in the summer (NOAA 2014; Jacobs and Terhune 2000; Rosenfeld et al. 1988). They are found throughout the Bay of Fundy, including near industrialized sites, but are most abundant in the outer Bay of Fundy (Stobo and Fowler 1994). The best Canadian estimate of abundance is approximately 10,000 individuals, based on summing other population estimates (COSEWIC 2007a).

Humpback whales are seasonally present primarily within the outer portion of the Bay of Fundy (NOAA 2012); they migrate to the Bay for feeding in the late spring, and remain until late fall (Ingram et al. 2007). The minimum population estimate for the Gulf of Maine and Bay of Fundy was 823 individuals in 2008 (NOAA 2012). Historical observations of humpback whales have been recorded in and around the LAA (Figures 7.18 and 7.19).

Another species that is seasonally present within the Bay of Fundy is long-finned pilot whale. This species can be found from the waters off North Carolina to North Africa and north to Iceland, Greenland and the Barents Sea (Waring et al. 2015). They often inhabit areas of high relief and submerged banks, and are also associated with the Gulf stream and thermal fronts along the continental shelf (Waring et al. 2015). Long-filled pilot whales are primarily distributed along the northeastern coast of the United States during the winter, and move northwards in the spring. In the late spring, summer, and fall, long-finned pilot whales are known to frequent more northern coastal waters, including around Georges Bank, the Gulf of Maine, the Bay of Fundy, and the Scotian Shelf (Hammill et al. 2001, Waring et al. 2015). It is not known whether the Northwest Atlantic population forms one or several separate stocks (Hammill et al. 2001, Waring et al. 2015). Based on the results of aerial surveys conducted in the summer of 2006 from the southern Gulf of Maine to the inner Bay of Fundy and the Scotian Shelf, it is estimated that there are approximately 5,636 long-finned pilot whales in the Northwest Atlantic. However, this estimate does not include Canadian waters north of the Scotian Shelf or waters along the shelf break south of Georges Bank and is therefore likely an underestimate (Waring et al. 2015). Historical observations of long-finned pilot whales have been recorded near the LAA in the Grand Manan Channel (Figure 7.19).

Minke whales found in the Bay of Fundy are considered to be part of the Canadian East Coast stock with an estimated abundance of 20,741 individuals in 2007 (NOAA 2013c). They are typically concentrated in the outer Bay (Ingram et al. 2007) from July to September, with some individuals remaining in the Bay year-round (Lien 2001).

The North Atlantic right whale is one of the most endangered whales in the world. The current best estimate is 522 individuals, based on photo-identification data up to and including 2013 (Pettis and Hamilton 2014). Their predicted distribution suggests that there is a high probability of North Atlantic right whales being present from June to October, with the possibility of individuals remaining until December

(Mellinger et al. 2007). They are most often observed in the outer Bay of Fundy, centered around the Grand Manan Basin (Brilliant et al. 2015), which is used primarily for foraging (Brown et al. 2009) and has been designated as critical habitat under *SARA*. The outer Bay of Fundy is also an important area for right whale nursing mother-calf pairs (Elvin and Taggart 2008). Historical observations of North Atlantic right whales have been recorded near the LAA (Figures 7.18 and 7.19).

Marine Birds

The Bay of Fundy is located on a major migration route that has been known for many years by birdwatchers and ornithologists as an important part of the Atlantic Flyway (Dietz and Chiasson 2000). The Atlantic Flyway is the easternmost of the four North American migration flyways, and spans over 4,800 km, from Baffin Island to the Caribbean (Ducks Unlimited n.d.). The large tidal exchange creates nutrient-rich upwelling areas in the outer Bay, which attracts a wide range of organisms from zooplankton to birds and whales. The rocky coastlines also offer foraging opportunities for shellfish-eating waterfowl such as the overwintering harlequin duck and locally breeding common eider. Harlequin duck is observed from early September to late May along the coast between St. Martin's and Grand Manan Island.

Pelagic seabirds that may be irregularly observed in the Bay of Fundy include Northern fulmar (*Fulmarus glacialis*), great shearwater (*Puffinus gravis*), sooty shearwater (*Puffinus griseus*), parasitic jaeger (*Stercorarius parasiticus*), south polar skua (*Stercorarius maccormicki*), Leach's storm-petrel (*Oceanodroma leucorhoa*), and Wilson's storm-petrel (Behrens and Cox 2013).

Black guillemot (*Cepphus grylle*) and Atlantic puffin (*Fratercula arctica*) are present year-round, and razorbill (*Alca torda*) is present in wintering colonies between fall and spring (Behrens and Cox 2013). Other alcids are variable from year to year and include dovekie and common and thick-billed murre.

Northern gannet (*Morus bassanus*) can be observed during most of the year with the exception of winter. Large flocks of hundreds of individuals can be seen during spring and fall migration. Small numbers of migrating common tern (*Sterna hirundo*) and Arctic tern (*Sterna paradisaea*) may also be observed during August and September.

The Bay of Fundy is home year-round to large numbers of gulls including herring gull (*Larus argentatus*), great black-backed gull (*Larus marinus*), ring-billed gull (*Larus delawarensis*), and black-legged kittiwake (*Rissa tridactyla*) (Behrens and Cox 2013). Other gull species which occur in winter include Iceland gull (*Larus glaucoides*) and glaucous gull (*Larus hyperboreus*).

Double-crested cormorant (*Phalacrocorax auritus*) can be observed passing in large flocks of hundreds of birds in September and October, with great cormorant (*Phalacrocorax carbo*) occurring from November and through winter in small numbers.

Marine waterfowl (e.g., geese, swans, ducks, and mergansers) include species that, outside of the breeding season, are found in the marine environment. There are two marine waterfowl SAR that can be observed in the Bay of Fundy: harlequin duck (*Histrionicus histrionicus*) and Barrow's goldeneye (*Bucephala islandica*), described below. Black scoter (*Melanitta americana*), surf scoter (*Melanitta perspicillata*), and white-winged scoter (*Melanitta fusca*), common loon (*Gavia immer*), and red-throated loon (*Gavia stellata*) may also be observed.

Common eider (*Somateria mollis*) is a local breeder, breeding in colonies on coastal islands in the Bay, including Machias Seal Island. Flocks of hundreds of common eiders can occur in April.

The outer Bay of Fundy provides a resting and foraging stopover for shorebirds during migration. The most common and numerous species of shorebirds observed during migration in the Bay of Fundy are semipalmated sandpipers (*Calidris pusilla*) and semipalmated plovers (*Charadrius semipalmatus*). Purple sandpiper (*Calidris maritima),* red-necked phalarope (*Phalaropus lobatus*), and piping plover (*Charadrius melodus*) also occur in the Bay of Fundy.

Table C.3 in Appendix C lists the avian SAR and SOCC that have been historically recorded near the LAA, including marine bird SAR and SOCC, and provides the federal *SARA* status, COSEWIC status, NB *SARA* status, and AC CDC S-rank for each of these historically recorded species. The information is not reproduced here, for brevity given the size of the table. Figures 7.18 and 7.19 show the locations of the historical observations recorded by AC CDC for the marine bird SAR and SOCC identified in Table C.3.

Table 7.11 lists the marine bird species that were incidentally observed during Stantec terrestrial bird surveys conducted at the landfall sites in June 2016, which included one marine bird SOCC (i.e., black guillemot). The locations of these incidental field observations are shown on Figures 7.18 and 7.19.

Table 7.11 Marine Bird Species Incidentally Observed During Terrestrial Bird Surveys at Landfall Sites

Species	Deer Island (Chocolate Cove)	Campobello West (Wilsons Beach)	Campobello East (Little Whale Cove)	Grand Manan (Long Eddy Point)	Grand Total
black guillemot (SOCC)	2	1	0	2	5
great black-backed gull	0	0	0	1	1
herring gull	0	1	1	3	5
ring-billed gull	0	0	0	1	1

Table 7.12 outlines the marine bird SAR that may occur in proximity to the LAA. Each are discussed below.

Table 7.12 Marine Bird SAR That May Occur in Proximity to the LAA

Common Name	Scientific Name	Federal *SARA* Schedule 1 Status[1]	COSEWIC Status[2]	NB *SARA* Schedule A Status[3]	AC CDC S-Rank[4]	NBDERD General Status[5]
Barrow's goldeneye (eastern population)	*Bucephala islandica*	Schedule 1, *special concern*	*special concern*	*special concern*	S2M, S2N	*sensitive*
harlequin duck	*Histrionicus histrionicus*	Schedule 1, *special concern*	special concern	endangered	S1B, S1S2N, S2M	*At risk*

Table 7.12 Marine Bird SAR That May Occur in Proximity to the LAA

Common Name	Scientific Name	Federal *SARA* Schedule 1 Status[1]	COSEWIC Status[2]	NB *SARA* Schedule A Status[3]	AC CDC S-Rank[4]	NBDERD General Status[5]
(eastern population)						
piping plover (*melodus* subspecies)	*Charadrius melodus*	Schedule 1, *endangered*	endangered	endangered	S1B, S1M	Breeding population: *at risk*
red knot (*rufa* subspecies)	*Calidris canutus rufa*	Schedule 1, i	endangered	endangered	S2M	Migrating population: *at risk*
red-necked phalarope	*Phalaropus lobatus*	–	*special concern*	–	S3M	Migrating population: *sensitive*
roseate tern	*Sterna dougallii*	Schedule 1, *endangered*	*endangered*	*endangered*	S1?B, S1?M	Breeding population: *at risk*

Notes:

[1] Government of Canada 2017a

[2] Government of Canada 2017a, 2017b

[3] Government of New Brunswick 2017

[4] *S1* = critically imperiled, *S2* = imperiled, *S3* = vulnerable, *S4* = apparently secure, *S5* = secure, *SNA* = not applicable (typically exotic species), *S#S#* = a numeric range rank indicates any range of uncertainty about the status of the species, ? Inexact or Uncertain = Denotes inexact or uncertain numeric rank, B = Breeding, N = Nonbreeding, M = Migrant (AC CDC 2017a).

[5] New Brunswick Department of Energy and Resource Development (NBDERD) 2017

Barrow's Goldeneye (Eastern Population)

Barrow's goldeneye is a medium-sized diving duck and is listed as *special concern* on Schedule 1 of *SARA*, *special concern* under NB *SARA*, and as *sensitive* under the New Brunswick Department of Energy and Resource Development (NBDERD) General Status of Wild Species. Barrow's goldeneye breeds along lakes in parkland, and winters along rocky coasts (Eadie et al. 2000). In Canada, the eastern population breed in Quebec. Approximately 400 birds winter in the Atlantic Provinces and Maine (Environment Canada 2013).

Harlequin Duck (Eastern Population)

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 NB *SARA*.

Piping Plover, melodus subspecies

Piping plover is a small migratory bird found on gravel-sand beaches throughout New Brunswick, mainly along the Northumberland Strait, but also occurring in the Bay of Fundy from the end of March to early May. The only identified breeding sites, as well as critical habitat for this species, are located in the inner Bay of Fundy (Environment Canada 2012); however, small numbers of piping plover (*melodus* subspecies) were observed on four occasions (i.e., 1976, 1986, 1996, and 2003) at Saints Rest Marsh and Beach and Courtenay Bay. Piping plover is listed as *endangered* under *SARA* (Government of Canada 2017b) and by COSEWIC (COSEWIC 2013).

Red Knot, rufa subspecies

The *rufa* subspecies of red knot, a shorebird, breeds in the central Canadian Arctic and winters in southern Patagonia and Tierra del Fuego (COSEWIC 2007b). Red knot is listed as *endangered* under Schedule 1 of *SARA* and NB *SARA*. A proposed Recovery Strategy and Management Plan for the Red Knot (*Calidris canutus*) in Canada was released in 2016, however, no critical habitat was identified. Coastal areas with extensive intertidal flats, usually sandflats (sometimes mudflats), are the preferred staging area for migrating red knots; the species feeds on bivalves and other benthic invertebrates (COSEWIC 2007b). The important areas for red knots in New Brunswick are Miscou Island and inner Bay of Fundy near Mary's Point (COSEWIC 2007b).

Red-necked Phalarope

The red-necked phalarope was listed as a species of special concern under COSEWIC in November 2014 (COSEWIC 2014a). This species migrates offshore in small flocks on floating seaweed and debris in the outer Bay of Fundy in late summer to early fall, and picks copepod-sized zooplankton prey from the water's surface (COSEWIC 2014b). The species prefers areas with high concentrations of prey biomass, such as the New Brunswick coast. Red-necked phalaropes breed on Arctic and subarctic tundra ponds. The migrating population that is found in New Brunswick is designated as sensitive under the NBDERD General Status of Wild Species (Government of New Brunswick 2017).

Roseate Tern

Roseate tern is a migratory coastal plunge diving seabird that is found breeding in flocks and nests on sand dunes, saltmarshes, and beaches. In North America, two populations of roseate tern breed on the Atlantic coast where they nest colonially with other tern species (common and Arctic). The Northeastern breeding population is estimated at fewer than 200 pairs and is mainly concentrated on a few coastal islands or headlands off the southern coast of Nova Scotia, with smaller numbers nesting on Machias Seal Island in the Bay of Fundy. Roseate tern is listed as *endangered* under *SARA* (Government of Canada 2017b) and by COSEWIC (COSEWIC 2009b). The recovery strategy for roseate tern does not identify any critical habitat within the Bay of Fundy (Environment Canada 2010).

7.6 PROJECT INTERACTIONS WITH THE MARINE ENVIRONMENT

Table 7.13 identifies the physical activities that may interact with the marine environment and result in a potential change in marine populations. These interactions are discussed in detail in Section 7.7 in the context of environmental effects pathways, standard and Project-specific mitigation/enhancement, and residual environmental effects. A justification for no environmental effect of some Project physical activities is provided following the table.

Table 7.13 Potential Project-Environment Interactions with the Marine Environment

Physical Activities	Potential Environmental Effect
	Change in Marine Populations
Construction	
Landfall construction	✓
Modification to cable riser stations	–
Cable installation in Head Harbour Passage and Grand Manan Channel	✓
Clean-up and revegetation	–
Inspection and energizing the Project	–
Emissions and wastes	✓
Land-based transportation	–
Marine transportation	✓
Employment and expenditure	–
Operation	
Vegetation management	–
Access road maintenance	–
Energy transmission	–
Infrastructure inspection, maintenance, and repair	✓
Emissions and wastes	✓
Land-based transportation	–
Marine transportation	✓
Employment and expenditure	–
Decommissioning	
Decommissioning of existing cables	✓
Reclamation	–
Emissions and wastes	✓
Land-based transportation	–
Marine transportation	✓
Employment and expenditure	–
Notes: ✓ = Potential interaction – = No interaction	

Land-based Project activities that are conducted above the HHWLT mark (i.e., modification to cable riser stations, clean-up and revegetation, and land-based transportation during the construction phase of the Project; vegetation management, access road maintenance, and land-based transportation during the operation phase of the Project; and reclamation and land-based transportation during the decommissioning phase of the Project) are considered unlikely to interact with the marine environment due to their lack of spatial overlap. The implementation of standard mitigation measures during land-based Project activities (refer to Section 6.7), such as erosion and sediment control, will further reduce the likelihood of potential interactions with the marine environment.

Inspection and energizing the Project during construction is not expected to interact with the marine environment, other than through the potential use of marine vessels to support inspection of the submarine cables (which is assessed in the context of marine transportation) and the potential underwater emission of EMF following energizing of the submarine cables (which is assessed in the context of Project emissions and wastes).

Energy transmission through the cables during Project operation is not expected to interact with the marine environment, other than through the potential emission of EMF (which is assessed in the context of Project emissions and wastes).

Employment and expenditure is not expected to interact with the marine environment during any phase of the Project. Project personnel will be accommodated in nearby lodgings within the Fundy Isles (i.e., on land) and onboard the same vessels that will be used to conduct Project activities in the marine environment. The use of these and other marine vessels to conduct Project activities, including accommodation of members of the marine-based Project workforce and transportation of Project personnel to/from the marine work site, is assessed in the context of marine transportation.

7.7 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON THE MARINE ENVIRONMENT

This section describes the potential interactions between the Project and the marine environment as identified in Section 7.6. Interactions between the Project and the marine environment that could result in a change in marine populations were assessed for each Project phase using the analytical assessment techniques described below.

7.7.1 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.

7.7.2 Change in Marine Populations

7.7.2.1 Project-Environmental Effects Pathways

Construction

Activities during landfall construction and cable installation (e.g., potential open-cut trenching in the intertidal zone at the landfall sites and burial of the cable to a depth of approximately 0.6 m on a “best efforts” basis within the Grand Manan Channel) could result in an increased risk of injury or mortality to fish and benthic marine invertebrates in the marine PDA due to effects of trenching and the potential increase in turbidity and TSS from siltation and sediment disturbance.

Sessile or slow-moving organisms may be buried, smothered, or crushed during the trenching/ploughing and installation of the submarine cables. Elevated TSS values have also been associated with high levels of stress in benthic invertebrates (Norton et al. 2002) and high levels of TSS can also affect fish. At high concentrations or during extended periods of exposure, environmental effects of suspended sediments on fish include: decreased feeding success; reduced ability to see and avoid predators; damaged gills; 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. An increase in TSS will also reduce the amount of light reaching any submerged vegetation (Park 2007), thereby decreasing photosynthesis. Waters with high TSS levels are also associated with reductions in dissolved oxygen and periphyton - primary producers that are sensitive indicators of environmental change (Ntengwe 2006, Birkett et al. 2007). Changes to surficial sediment chemistry could also occur as a result of bottom disturbance and re-suspension of existing sediments.

Installation of the submarine cables is expected to result in temporary disruption of the benthic habitat in the footprint of the marine PDA. The marine footprint includes segments of marine cable measuring 14.5 km and 3.4 km in the Grand Manan Channel and Head Harbour Passage, respectively, with the potential disturbance area of up to 10 m in width. The installation of the marine cables may result in the direct disturbance of up to 32,120 m^2 and 142,100 m^2 of seabed for the Head Harbour Passage and Grand Manan Channel, respectively. It is expected that open-cut trenching (if applicable) and cable burial will cause an initial effect on benthic community composition immediately after trenching/ploughing.

Existing sources of habitat disturbance within the LAA may include commercial fishing activities, specifically scallop dragging. This method of scallop fishing has been associated with direct physical and biological effects on benthic ecosystems such as reducing habitat complexity and heterogeneity (Currie and Parry 1996), direct benthic infaunal mortality (Boulcott et al. 2014), and mobilization of sediment increasing the release of nutrients and reducing sediment food quality (O'Neill et al. 2013; Watling et al. 2001). 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).

Marine transportation activities will be associated with cable installation. 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 Bay of Fundy if improperly discharged. The marine environment could also be adversely affected by a Project-related change in marine populations due to potential effects on all marine species resulting from temporary and localized changes in water quality caused by routine discharges from Project vessels (e.g., bilge water, ballast water, deck drainage, sewage). Such changes could cause temporary behavioural effects (e.g., avoidance/displacement or attraction) for marine species within the immediate area, as well as an increased risk of potential injury or mortality (e.g., from exposure to residual hydrocarbons).

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 at the cable landfall sites.

Noise and lights during HDD operations for the installation of the cable at landfall sites (if used) have the potential to create disturbances to birds in surrounding area. It is possible for birds to vacate areas in close proximity to the source of disturbance, or impair activities such as foraging, breeding, or rearing of young. These effects can extend several hundred metres into the surrounding undisturbed habitat.

Increased underwater sound levels associated with possible open-cut trenching and installation of submarine cables (both in the intertidal zone at landfall sites as well as at sea) may also cause temporary behavioural changes in macro-invertebrates, fish, and marine mammals. Behavioural responses will likely result in slight changes of local distributions of these animals until the source is removed. 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 landfall construction (HDD), possible open-cut trenching, cable installation, and movement of marine vessels associated with these activities. 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 potential amount of underwater noise created during open-cut 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.

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).

The Project is located in proximity to several protected and sensitive areas (Section 7.5.3.3). The Head Harbour Passage segment of the marine PDA overlaps spatially with portions of the Quoddy Region IBA; the Whole of Quoddy Region EBSA; and the Head Harbour, West Isles, and the Passages EBSA. The Grand Manan Channel segment of the marine PDA overlaps spatially with the Grand Manan Archipelago IBA, the Whole of Quoddy Region EBSA; and the Long Eddy, Northeast Grand Manan EBSA. During construction, the marine environment could be adversely affected by a Project-related change in marine populations due to potential effects on these protected and sensitive areas, since the marine species that use these areas will be exposed to the same potential environmental effect pathways as described above for fish, marine mammals, sea turtles, and migratory birds (e.g., change in risk of injury or mortality associated with direct physical disturbance of benthic habitat, changes in water quality caused by the suspension of sediments and increase in TSS, changes in water quality caused by routine discharges from Project vessels, collision risk, artificial night lighting, etc.). The marine species that frequent or inhabit such areas may also be subject to sensory disturbance, particularly for those protected and sensitive areas that overlap spatially with a portion of the marine PDA or are in close enough proximity to the marine PDA that Project construction activities may be visible or audible.

Operation

Once installed, the submarine cables will have no further physical interaction with the marine environment other than their continual presence. Because there will be no direct physical interaction with marine species associated with the presence of the active cables after they have been installed, other than the emission of electromagnetic fields (EMF) during operation (discussed below), physical interactions with the cables due to their presence in the marine environment 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 primary environmental effect associated with inspection and maintenance are 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. The Project vessels required for inspection and maintenance may also affect water quality through routine discharges. Similar to the construction phase, artificial night lighting on Project vessels during the operation phase has potential to cause an increased risk of injury or mortality for marine birds.

If cable repairs are necessary, potential effects on fish, marine mammals, sea turtles, and migratory birds resulting from pulling the cable from the seabed and subsequently reburying it (if required) during the operation phase of the Project would be similar to those associated with Project construction activities, but more localized.

The transmission of energy through the submarine cables will generate emissions of EMF. EMF is a force consisting of direct and induced electric and magnetic components. Some species of marine fish, shellfish and marine mammals have sensitivities to EMF. The generation and emission of EMF from a submarine cable may interact with certain marine species' ability to navigate and locate prey or predators.

Three types of EMF are produced by a submarine cable:

- The direct electric field, which is the primary mode of transmitting electricity along the cable. This field is contained within the submarine cable by insulation and sheathing.
- The magnetic field, which is produced by the transmission of electricity. This field is emitted from the submarine cable and cannot be completely insulated.
- The induced electric field, which is produced by the alternation of the alternating current (AC) magnetic field or from water current flows or marine organisms swimming through the field. This field is emitted from the submarine 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.

Magnetic fields and induced electric fields are created and emitted by the transmission of power through the submarine cables. The 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). 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 Bay of Fundy may interact with navigation and predator/prey detection in marine fish.

When power is transferred through submarine cables, particularly as alternating current, heat is dissipated. In general, XPLE HVac cable sheath operates at approximately 90ºC internally, while it is only warm to the touch on the outside of the cable. The operation of a submarine cable may result in localized changes to the benthic infauna directly below the cable, resulting in organisms preferring cold temperatures being replaced by more temperate species.

The Project is located in proximity to several protected and sensitive areas (Section 7.5.3.3). The Head Harbour Passage segment of the marine PDA overlaps spatially with portions of the Quoddy Region IBA; the Whole of Quoddy Region EBSA; and the Head Harbour, West Isles, and the Passages EBSA. The Grand Manan Channel segment of the marine PDA overlaps spatially with the Grand Manan Archipelago IBA, the Whole of Quoddy Region EBSA; and the Long Eddy, Northeast Grand Manan EBSA. During operation, the marine environment could be adversely affected by a Project-related change in marine populations due to potential effects on these protected and sensitive areas, since the marine species that use these areas will be exposed to the same potential environmental effect pathways as described above for fish, marine mammals, sea turtles, and migratory birds (e.g., change in risk of injury or mortality associated with changes in water quality caused by routine discharges from Project vessels; collision risk; artificial night lighting; and, if removal and/or reburial of the cable is required for cable repairs, direct physical disturbance of benthic habitat, changes in water quality caused by the suspension of sediments and increase in TSS, could occur).

Decommissioning

If the existing submarine cables are abandoned in place during decommissioning of the Project, no further physical interaction with the marine environment is anticipated other than their continual presence. The effect on substrate quality may be neutral in areas where the cable is laid over top of areas already containing a large amount of hard substrate. However, in some cases, the surface-laid cable may introduce new or additional hard, multi-dimensional substrate that could have a positive environmental effect for colonization by epibenthic organisms, thereby enhancing habitat quality and causing a beneficial environmental effect.

If the existing submarine cables are removed, potential environmental effects pathways for decommissioning the existing cables are generally anticipated to be similar to the environmental effects pathways identified above for the construction phase. Much like the potential open-cut trenching in the intertidal zone during landfall construction and burial of the cable during cable installation in Grand Manan Channel, excavation of the existing submarine cables during decommissioning (if applicable), and associated marine transportation and emissions and wastes, has potential to result in sediment disturbance, increased TSS, an increased risk of injury or mortality to fish and benthic marine invertebrates, disturbance of benthic habitat and communities, and increased underwater sound levels, all of which have the potential to contribute to a change in marine populations.

Potential environmental effect pathways associated with marine transportation and emissions and wastes during decommissioning are also expected to be similar to those associated with marine transportation during construction.

Another potential environmental effect pathway that may be associated with removal of the existing cables during decommissioning is the removal of hard, multi-dimensional substrate (i.e., surface-laid cable). This could adversely affect habitat quality in areas where hard substrate is scarce, and has potential to cause injury or mortality to any epibenthic organisms that have colonized the existing cables.

Decommissioning of abandonment of the proposed new submarine cables will occur at the end of their useful service life in accordance with the regulations and practices in place at that time.

7.7.2.2 Mitigation

Project activities that have the potential to interact with marine populations will use avoidance or mitigation measures to manage environmental effects during construction and operation. The use of standard mitigation measures and a Project-specific Environmental Management Plan (PSEMP) will assist in managing environmental effects. Using the mitigation measures, temporal avoidance (where possible), and best management practices (BMPs) described in the PSEMP will assist the Proponent in reducing residual environmental effects on marine populations.

Throughout construction and operation, NB Power will mitigate activities that interact with marine populations by implementing the following mitigation measures:

- All marine Project activities will be conducted in accordance with the requirements of the Canadian Coast Guard Marine Communication and Traffic Services (CCG-MCTS).
- 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 fishers, DFO and other regulators.
- Erosion and sediment control measures will be included in the PSEMP for works around sensitive areas, such as shorelines or areas with steep slopes.
- HDD may be used to bury the submarine cables at landfall sites and thereby avoid mortality and disturbance in the nearshore marine environment.
- Breaching of the seabed with HDD borehole exits may result in a small release of drilling mud. Mitigation options will be determined in detailed design phase with more geotechnical information. The loss of drilling fluids is unavoidable; however, the effect will be localized and best practices with proper contingency planning will minimize the fluid loss. Good mud system control and bit locational controls through accurate telemetry technology is paramount in mitigating drilling fluid loss. Depending on the geology, options may be available to alter the mud composition near the exit location. The use of divers and suction equipment may also be an option depending on safety conditions.
- Project related vessel traffic will be restricted to the marine PDA, where possible.
- Construction vessels will operate at reduced speeds, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife.

- Routine effluents and operational discharges produced by cable-laying and support vessels (e.g., grey and black water, bilge water, deck drainage, discharges from machinery, and non-hazardous waste material) will be managed in accordance with the International Convention for the Prevention of Pollution from Ships (MARPOL) and International Maritime Organization (IMO) guidelines, of which Canada has incorporated provisions under various sections of the Canada Shipping Act.
- 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 Bay of Fundy. Vessel hulls will be cleaned and/or inspected prior to entering the Bay of Fundy, where necessary.
- All marine-based work undertaken by foreign vessels must be undertaken pursuant to a Coasting Trade Permit issued under the Coasting Trade Act, and will comply with applicable regulations, IMO guidelines and international conventions, including MARPOL.
- 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.
- Scheduling of Project activities will be coordinated through consultation with local fish harvesters and other stakeholders and best-efforts will be made to schedule activities to reduce interference with fisheries and other activities.
- 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.
- Inspection and maintenance support vessels during Project operation will operate at reduced speeds when possible, to reduce the amount of underwater noise created and the risk of vessel strikes with marine wildlife.
- A permit to handle storm-petrels will be obtained by the Canadian Wildlife Service (CWS) and held onboard Project vessels to cover personnel involved in bird collision and stranding incidents. These designated crew members will conduct routine checks of Project vessels for stranded seabirds. If any Leach’s storm-petrel becomes stranded on a Project vessel, it will be handled and released in accordance with the procedures outlined in The Leach’s Storm-Petrel: General Information and Handling Instructions (Williams and Chardine n.d.).
- The potential for collisions with marine wildlife will be reduced by the slow speed of the cable ship, which will be operate at a speed of approximately 5 knots while engaged in cable burial and will have a maximum speed of 10 knots during transit. No high-speed manoeuvers will be conducted by any Project vessels during cable installation.
- Project vessels will adhere to the general guidelines for vessels operating in the vicinity of marine mammals that are specified in section A2 of the 2017 annual edition of Notices to Mariners (DFO 2017c). Adherence to these guidelines includes, but is not limited to, the following measures:
  - Project vessels will approach areas of known or suspected marine wildlife activity with extreme caution.
  - Project vessels will reduce their speeds to less than 7 knots when within 400 m of the nearest marine mammal.
  - Project vessels will not approach any marine mammals and will maintain a distance of at least 100 m from the nearest marine mammal.
- Marine-based Project activities will temporarily halt if a marine mammal or sea turtle is observed within 100 m of Project vessels or equipment.

7.7.2.3 Characterization of Project Residual Environmental Effects

Residual environmental effects on the marine environment VC from Project construction, operation and decommissioning are anticipated to occur. These environmental effects have the potential to result in fish mortality, and temporary disruption of habitat. Temporary behavioral changes in marine fish and wildlife may occur from noise generated during Project construction. These residual environmental effects are separated by Project phase and characterized in the following sections.

Construction

Construction of the Project has the potential for residual environmental effects as a result of cable installation in Head Harbour Passage and Grand Manan Channel. These project activities may physically alter marine benthic habitat and the marine acoustic environment from trenching activities and increased marine traffic. Marine emissions and wastes released during construction also have the potential to alter water quality and sediment quality and alter habitat for marine species.

During cable laying operations, specifically trenching in the Grand Manan Channel, there will be increased risk of mortality or injury to fish and benthic marine invertebrates in the marine PDA directly from trenching, and indirectly from smothering due to sediment deposition. Potential interactions with benthic invertebrates are expected to be minimal along portions of the marine PDA where burial is not feasible or is not proposed (i.e., across Head Harbour Passage) and the cable is simply laid across the seabed.

During trenching and installation of the submarine cables sessile or slow-moving benthic organisms may be buried, smothered, or crushed. Typically, there is an initial effect on benthic community composition immediately after dredging, though it is low in magnitude, Constantino et al. (2009) determined there were 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. 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 effects 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).

Changes to surficial sediment chemistry could occur as a result of bottom disturbance and re-suspension of existing sediments. Sediment samples collected in May and June 2017 indicate that the sediment meets the CCME Sediment Quality Guidelines (Marine) and the *CEPA* Disposal at Sea guidelines for all parameters except arsenic, which exceeded the ISQG guideline in three out of the seven samples that were analyzed. Given these low baseline levels, the risk of bioaccumulation of potential toxins in marine mammals, fish and shellfish is low as all of the parameters analyzed in sediments (Section 7.5.2) were below the limits set by the CCME Sediment Quality Guidelines (Marine) and the *CEPA* Disposal at Sea guidelines.

TSS in the water column generated by the trenching activities has the potential to increase the risk of mortality to benthic and pelagic species near the trenching activities. 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). The duration of TSS in suspension and the geographic distance over which the sediment is disperses beyond the immediate footprint of disturbance depends on several factors: particle size, duration of disturbance, and local oceanographic (current) conditions. CSR conducted hydrographic, topographic, and geophysical surveys of the proposed cable route between August and October 2016 (CSR 2017). The results showed that bottom currents are relatively strong, while the substrate is typically a mixture of rock and sand. Field surveys conducted by Stantec in June 2017 confirmed that the substrate is relatively coarse. Therefore, the effects of TSS are expected to be minimal during drilling and cable installation activities. The effects of TSS will be limited to construction period and will not be focused at one single location. Based on past evidence, this environmental effect will be reversible within a matter of hours to days. When compared with other sources of sediment disturbance, such as dredging, a decrease in median grain size of sand between dredged areas and non-disturbed (control) areas has been reported (Constantino et al. 2009). There may be a temporary effect on the habitat of marine mammals through potential increases in turbidity due to the suspension of sediments due to cable installation activities. However, this effect will be temporary and limited in extent given the expected limited amount of associated sediment and short duration of disturbance at any given location.

When trenching and cable laying operations are compared with other activities such as bottom trawling and anchoring, the effects of cable laying are relatively less intrusive as they occur during a short period of time, are not repetitive, and occur in a small footprint. No unique or sensitive bottom habitats (e.g., eelgrass beds) were identified during the benthic habitat surveys of the marine PDA and therefore sensitive habitats will not be directly disturbed or lost as a result of cable installation activities.

If HDD can be used at landfall locations, there are minimal residual environmental effects from using HDD to bury the submarine cable in the nearshore marine environment as compared to burying the cable using trenching methods or placement of rock for protection. However, once drilling breaks through the seafloor, hydraulic pressure differences between the entry borehole on land and the exit borehole in the ocean may lead to a discharge of drilling mud containing bentonite, a drilling fluid lubricant. Bentonite is non-toxic and is easily dispersed in flowing water. Any such releases during construction will be short-lived, localized, and are expected to disperse with the currents in the LAA, resulting in minimal residual environmental effects. Specialized mitigation will be evaluated following final design and siting of the exit location and characterization of benthic habitat.

While there will be residual environmental effects from cable installation (including potential trenching and burial in Grand Manan Channel) during construction, potential residual effects associated with direct physical disturbance will be short-term and confined to a relatively small area of the marine environment. For potential open-cut trenching in the intertidal zone at the landfall sites, potential residual effects associated with direct physical disturbance will be limited to a 10 m wide PDA corridor extending from HHWLT to the depth contour of 3 m below LLWLT at each landfall site; this amounts to total areas of approximately 820 m^2 at Chocolate Cove, approximately 970 m^2 at Wilsons Beach, approximately 1,290 m^2 at Little Whale Cove, and approximately 1100 m^2 at Long Eddy Point. These are very limited geographic extents in comparison to the area of the LAA and the Bay of Fundy as a whole, and apart from critical habitat discussed previously, fish habitat availability in the Bay of Fundy is not limiting.

For cable installation beyond the intertidal zone, potential residual effects associated with direct physical disturbance will be limited to a 10 m wide PDA corridor extending from 3 m below LLWLT at each landfall site seawards across Head Harbour Passage and Grand Manan Channel, respectively; this amounts to total areas of approximately 32,120 m^2 in Head Harbour Passage and approximately 142,100 m^2 in Grand Manan Channel. However, the spatial extent of direct physical disturbance is likely to be smaller than indicated above since the actual footprint of disturbance for placement of the proposed cable will be 2 m wide in the portions of the marine PDA that are located in the Passage and are more than 3 m below LLWLT (i.e., the portions of the marine PDA beyond the area in which HDD or open-cut trenching will be used at the landfall sites). Again, in comparison to the amount of habitat in the outer Bay of Fundy, this represents a small area of disturbance, and effects will be short term and localized for a few hours to days following cable installation.

The potential for mortality of marine fish and benthic invertebrates will be confined to the marine PDA within highly localized areas affected by disturbance of the seabed by cable-laying and burial. Harm to pelagic fish and mobile invertebrates because of physical disturbance is unlikely, as these species are typically able to avoid crushing. There may be a loss of a limited number of sessile benthic species from benthic habitats during trenching and cable installation but this would be limited to the marine PDA. 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 or cable laying process, the effect will be irreversible.

Cable laying operations and the related 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. Acoustic emissions from activities associated with the Project are not likely to induce auditory injury or auditory fatigue in any species of marine mammal within the outer Bay of Fundy. With the application of mitigation to reduce the potential for collisions of cable-laying and associated vessels with large whales and sea turtles, the likelihood for a residual environmental effect of mortality, especially for the cetacean species, is low. Any potential ploughing and/or trenching activities of the seabed will be conducted by a slow-moving vessel with the primary source of vessel noise being generated by propeller cavitation, which would be considerably less than a vessel travelling at higher speeds (i.e., what would be expected of regular shipping traffic travelling through the Bay of Fundy). Moreover, any incremental noise would be temporary in any location as the cable-laying vessel moves along the route.

The installation of subsea cables will require the operation of moderately large vessels within the marine PDA. Operation of such vessels within known marine mammal habitat has the potential to result in collisions. Larger cetaceans (e.g., fin whale, North Atlantic right whale, and humpback whale) are at the greatest potential risk of vessel collisions (Laist et al. 2001). Vessels associated with the Project will transit relatively slowly (maximum vessel speed is expected to be approximately 10 knots), which will reduce the likelihood of collisions with marine mammals.

Behavioural avoidance of high traffic areas by marine mammals may reduce the incidence of vessel strikes to individuals, but may also displace marine mammals from important foraging habitat where it overlaps with these traffic areas (Mayo and Marx 1990, Terhune and Verboom 1999, Nowacek et al. 2004). Reduced foraging efficiency and increased energy expenditure from behavioural avoidance are expected to be minimal. 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 100 m of Project vessels or equipment.

Mortality to marine birds, caused by disorientation due to artificial lighting from Project vessels, is expected to be minimal assuming mitigation measures noted above will be implemented and the short-term duration of construction activities and the spatial extent. Any marine discharges or emissions 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 the risk to marine birds, mammals and fish and avoid the introduction of marine invasive species.

Marine Protected Areas and sensitive marine habitats were described in Section 7.5.3. As shown in Figure 7.17, the marine PDA overlaps the sensitive areas in relatively small proportions and marine PDA does not bisect any protected areas.

The most substantial amount of spatial overlap occurs in the Long Eddy, Northeast Grand Manan EBSA, where approximately 28% of this EBSA is intersected by the LAA and approximately 0.27% is intersected by the marine PDA. Unlike some other EBSAs (e.g., Head Harbour, West Isles, and the Passages EBSA), the Long Eddy, Northeast Grand Manan EBSA was not identified on the basis of high benthic biodiversity or unique habitat; the Long Eddy, Northeast Grand Manan EBSA was identified as an EBSA on the basis of substantial marine mammal and marine bird aggregations (Buzeta 2014).

Approximately 23% of the herring spawning area off the coast of Grand Manan Island is intersected by the LAA and approximately 0.2% is intersected by the PDA. Project activities with the potential to cause direct physical disturbance to the benthic environment (e.g., cable installation, inspection, maintenance, and repair) could damage or destroy eggs adhering to benthic materials in the herring spawning area. However, in consideration of the temporary and localized nature of these activities, which will be carried out over a relatively short amount of time (i.e., in the order of one to three weeks) at any given point along the marine PDA, and NB Power's commitment to schedule in-water work in consideration of sensitive biological periods (e.g., reproductive life stages) where practical, residual environmental effects on herring populations are anticipated to be low in magnitude.

The LAA overlaps the remaining protected or sensitive areas between 1% and 6% of their respective total areas. Table 7.14 lists the sensitive areas and the proportion covered by the marine PDA and the LAA.

Table 7.14 Spatial Overlap of the Project with Sensitive Areas

Sensitive Area	Total Area (Approximate Area Occupied by Sensitive Area)	Spatial Overlap of LAA within Sensitive Area (Approximate Amount of Total Area Intersected by LAA)	Spatial Overlap of PDA within Sensitive Area (Approximate Amount of Total Area Intersected by PDA)
Head Harbour, West Isles, and the Passages EBSA	114 km^2	6%	0.06%
Long Eddy, Northeast Grand Manan EBSA	35 km^2	28%	0.27%
Whole of Quoddy Region EBSA	1,450 km^2	1%	0.01%
Grand Manan Archipelago IBA (NB011)	1,001 km^2	2%	0.02%
Quoddy Region IBA (NB037)	130 km^2	5%	0.05%
Herring Spawning Area	35 km^2	23%	0.2%

Based on the limited spatial overlap between the Project and the protected or sensitive areas, the Project is not anticipated to result in any measurable, direct physical residual environmental effects on the protected or sensitive areas key ecologically and biologically significant attributes. A temporary and localized increased risk of mortality or physical injury for marine species and sensory disturbance may occur from interactions with Project vessels engaged in cable installation, inspection, maintenance, and decommissioning activities, but this activity is anticipated to be temporary and with the implementation of mitigation measures, the risk is to marine wildlife is low.

Operation

Once installed, the submarine cables will have no physical interaction with the marine environment other than their continual presence. Project interaction with the marine environment during the operation phase will occur during inspection, maintenance and repair and the respective vessel traffic required during these activities. Emissions from the Project vessels are also assessed in the operation phase. EMF emissions from the cable are discussed in this section as they relate to marine wildlife species.

Effects from vessel traffic will occur during maintenance and repair. Multi-beam and side-scan sonar surveys may be conducted, as required. The vessels required for these activities 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. Effects on the marine environment from marine traffic during the operation phase is expected to be similar to those effects discussed during the construction phase. The effects are anticipated to be low in magnitude and occur infrequently and be short in duration.

The transmission of electricity through the submarine 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 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. In a review of 24 submarine cables, Normandeau et al. (2011) found that the magnetic field was strongest directly over the cables and then rapidly decreased with increased distance from each cable.

Natural sources of EMF are present in the marine environment and in the Bay of Fundy, including the earth's geomagnetic field. The intensity of the natural geomagnetic field changes with latitude. Near the equator values are approximately 30 micro Tesla (μT) while near the north and south poles values are approximately 70 μT. In the Bay of Fundy, natural geomagnetic fields are approximately 53 μT (Normandeau et al. 2011).

The submarine cables to be installed are a 69 kV AC cable capable of carrying up to 50 MW. 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. Using the modelled data from Normandeau et al. (2011), an average 69 kV cable buried laid on the seafloor has a predicted magnetic field of approximately 8 μT 1 m above the cable and decreases to 1.5 μT at a distance of 4 m and 0.2 μT at 10 m.

The EMF assessment focuses on benthic animals as they interact with the benthic marine habitat and are more likely to be in close proximity to electrical and magnetic fields from the cable.

The benthic species identified to potentially interact with Project-related EMF include:

- American lobster – CRA fishery species;
- smooth skate (*Malacoraja senta*) (Laurentian-Scotian population) – SOCC; and
- 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 would be most sensitive to magnetic fields, with smooth skate and thorny skate most sensitive to electric fields. Recent literature indicates skates 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 they use this magnetic field for migration and homing (Lohmann et al. 2007; Boles and Lohmann 2003; Cain et al 2005). 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 submarine cable (Normandeau et al. 2011). The Pacific Northwest National Laboratory is currently conducting research into the effects of EMF on adult American lobster. The results indicate that there were no statistical changes in behaviour or localized movement of American lobster in a tank with magnetic fields between 500 μT and 1,100 μT as compared to a reference tank (PNNL 2013).

The U.S. Department of Energy is funding research into the effects of magnetic fields from an existing 35 kV AC submarine 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 submarine cable (Gill and Bull 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 (Gill and Bull 2015).

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). There is limited research published with respect to the potential biological effects on marine mammals from magnetic fields generated by the transmission of high voltage AC power through submarine cables. Other information (Normandeau et al. 2011), however, has not substantiated these concerns. Although magnetic fields potentially generated by the submarine cables may be detectable by cetaceans that use the earth’s magnetic field for navigation during migrations in the Bay of Fundy, the magnetic fields emitted are limited spatially. The strength of these magnetic fields also markedly decrease with increases in distance from the cables.

Sea turtles, such as the loggerhead turtles, are sensitive to magnetic fields and use magnetic fields for orientation during long-range migrations (Loahnmann et al 1997). There are indications that this sense is critical for the species primary orientation to approach the general vicinity of a destination (e.g. nesting beaches, feeding grounds), but that adjustment is accomplished by using olfactory and visual cues.

Hatchlings exposed to low intensity pulsed magnetic fields swam randomly compared to control animals that swam easterly. Power cables placed in the immediate vicinity of nesting beaches could affect the ability of hatchlings to swim towards nursery grounds. It is assumed that any of the sea turtle species could be affected the same way (Normandeau et al. 2011). However, there are no known sea turtle nesting sites in the Bay of Fundy.

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; 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. This limited spatial extent of magnetic fields associated with the 69 kV high voltage AC cables and the mitigation planned by Project design (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 submarine high voltage AC 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).

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 (Rajidae). 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 135 kV subsea cable with an operating induced electric field of 36 μV/m.

Partial burial of the cable, on a best attempt effort, approximately 0.6 m beneath the seabed in the Grand Manan Channel crossing is anticipated to reduce the magnitude of potential residual adverse environmental effects. Considering the lack of demonstrated adverse effects and the limited spatial extent of induced electric fields associated with 69 kV high voltage AC cables and the mitigation planned by Project design (i.e., cable sheathing, armouring, and partial burial), the residual adverse environmental effects of induced electric fields on CRA and SOCC species and changes to their population are expected to be not significant.

Decommissioning

The activities required to decommission the existing submarine cables will be similar in scope to the activities conducted during construction. Should the existing cables be decommissioned in place, any environmental effects on the marine environment would be shorter in duration than those during construction.

During decommissioning, there may be residual adverse environmental effects from excavation in the intertidal zone and marine environment, as well as associated marine transportation and emissions and wastes; the characteristics of these residual environmental effects are anticipated to be similar to those described in the characterization of residual effects for the construction phase.

For removal of the existing cables from the intertidal zone at the landfall sites, potential residual effects associated with direct physical disturbance are limited to a 10 m wide PDA corridor extending from HHWLT to the depth contour of 3 m below LLWLT at each landfall site; this amounts to total areas of approximately 450 m^2 at Chocolate Cove, approximately 490 m^2 at Wilsons Beach, approximately 940 m^2 at Little Whale Cove, and approximately 450 m^2 at Long Eddy Point.

For removal of the existing submarine cables beyond the intertidal zone, potential residual effects associated with direct physical disturbance are limited to a 10 m wide PDA corridor extending from 3 m below LLWLT at each landfall site across Head Harbour Passage and Grand Manan Channel; this amounts to total areas of approximately 31,900 m^2 in Head Harbour Passage and approximately 142,000 m^2 in Grand Manan Channel. These are very limited geographic extents in comparison to the area of the LAA and the Bay of Fundy as a whole, and apart from critical habitat discussed previously, fish habitat availability in the Bay of Fundy is not limiting.

As was the case for the construction phase, potential residual effects associated with direct physical disturbance during decommissioning (i.e., removal of existing cables) are short-term and confined to a relatively small area of the marine environment. However, the spatial extent of potential residual effects associated with direct physical disturbance varies slightly from the construction phase since the total length of the existing cables is slightly shorter than the total length of the proposed cables.

However, the spatial extent of direct physical disturbance is likely to be smaller than indicated above since the actual footprint of disturbance for removal of the existing cables will be 4 m wide in the portions of the marine PDA that are located in Head Harbour Passage and Grand Manan Channel and are more than 3 m below LLWLT (i.e., the portions of the marine PDA beyond the intertidal zone).

7.8 SUMMARY OF PROJECT RESIDUAL ENVIRONMENTAL EFFECTS

Table 7.15 summarizes the environmental effects assessment and prediction of residual environmental effects. This environmental effects assessment is based on those interactions between the Project and the marine environment rated as having a potential interaction in Table 7.13.

Table 7.15 Summary of Project Residual Environmental Effects on the Marine Environment

Residual Environmental Effect	Residual Environmental Effects Characterization								
	Project Phase	Direction	Magnitude	Geographic Extent	Frequency	Duration	Timing	Reversibility	Ecological and Socioeconomic Context
Change in marine populations	C	A	L	PDA-LAA	MI	ST	A	R	D
	O	A	L	PDA-LAA	C-MI	LT	N/A	R	D
	D	P-A	L	PDA-LAA	MI-C	ST	A	R	D

KEY
See Table 7.2 for detailed definitions

Project Phase
C: Construction
O: Operation
D: Decommissioning

Direction:
P: Positive
A: Adverse

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

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

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term
P: Permanent
N/A: Not applicable

Frequency:
S: Single event
MI: Multiple Irregular event
MR: Multiple Regular event
C: Continuous

Timing:
A: Applicable
N/A: Not applicable

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socioeconomic Context:
D: Disturbed
U: Undisturbed

In relation to the Project, construction activities such as cable installation in Head Harbour Passage and Grand Manan Channel and the resulting increased marine traffic and marine emissions may result in a change in marine populations through physical disturbance of benthic habitat, changes in the acoustic environment, and changes in sediment or water quality. These environmental effects are considered adverse, but low in magnitude. The environmental effects of cable trenching and laying (including increased marine traffic and marine emissions) are anticipated to occur as multiple events over a short period of construction (i.e., in the order of weeks), and will be limited to the marine PDA for physical disturbance, and the LAA for changes in the underwater acoustic environment. The presence of local commercial fisheries (which drag or trawl through benthic habitat) and associated marine traffic indicate the existing environment within the LAA has been previously disturbed, thereby resulting in a disturbed ecological and socioeconomic context, and while timing is applicable, construction activities can be timed to avoid sensitive periods for marine species or fisheries, if required. As no unique or sensitive bottom habitats were identified during the benthic habitat surveys, changes to the benthic habitat from Project activities are considered reversible, and are expected to return to pre-construction conditions following the conclusion of cable trenching and laying.

Operation of the Project is expected to result in the generation and emission of induced electric and magnetic fields and increased vessel traffic for periodic cable inspection, maintenance and repair activities. Effects on marine populations may result from electric and magnetic fields emanating from the cable or through changes in the underwater acoustic environment from marine vessel traffic. Cable sheathing and insulation of the cables, combined with their burial where it is possible to do so, are anticipated to reduce the magnitude of potential residual adverse environmental effects. Environmental effects are anticipated to be adverse, though with planned mitigation will be low in magnitude and will occur within the marine PDA. Environmental effects on marine populations from marine traffic are also anticipated to be low in magnitude and extend to the LAA. These environmental effects are long-term, but will be reversible upon decommissioning of the Project. The generation of low-level electric and magnetic fields will be continuous during the operation phase of the Project, while marine traffic and related emissions are expected to occur on an infrequent basis, as needed. Timing is not applicable because low-level EMF emissions will occur throughout the Project life (though mitigated) and inspection and maintenance activities could occur at any time, regardless of seasonality. The presence of local commercial fisheries (which drag or trawl through benthic habitat), marine traffic, and historical cable installation indicates the ecological and socioeconomic context within the LAA has been previously disturbed.

The activities required to decommission the existing submarine cables will be similar in scope to the activities conducted during construction. Should the existing cables be decommissioned in place, any environmental effects on the marine environment would be shorter in duration than during construction. Decommissioning is expected to result in a short-term disturbance to the sea floor while removal is taking place, and environmental effects would be adverse and low in magnitude and limited to the PDA and immediate area surrounding it. Decommissioning of the marine cables would increase marine traffic within the PDA and produce a change in the underwater acoustic environment within the LAA. The environmental effect of increased marine traffic will be adverse and occur as multiple events for a short-term during decommissioning. Though timing is applicable, decommissioning can be timed to avoid sensitive periods for marine species, if required. As the marine environment is ecologically disturbed as noted above, the additional environmental effects from increased marine traffic are considered to be low in magnitude. Decommissioning of the existing subsea cables will also result in a positive effect on marine populations through a decrease in induced electric and magnetic fields. These positive environmental effects are continuous, spatially limited to the PDA, and reversible. As the marine environment is ecologically disturbed, the positive environmental effects from a decrease in induced electric and magnetic fields are considered to be low in magnitude.

7.9 DETERMINATION OF SIGNIFICANCE

In consideration of the Project planning, design, and mitigation, the residual environmental effects of a change in marine populations from the Project activities or components during all phases of the Project are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general effects of construction activities on the marine environment and the effectiveness of mitigation measures. Activities associated with construction and operation of the Project components can be mitigated using the proposed known mitigation and environmental protection measures, as described in Section 7.7.2.2.