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Fundy Ocean Research Centre for Energy
(Minas Basin Pulp and Power Co. Ltd.)

Environmental Assessment Registration Document – Fundy Tidal Energy Demonstration Project Volume I: Environmental Assessment

Project Number 107405

June 2009

AECOM

Minas Basin Pulp and Power

Volume 1: Environmental Assessment
Fundy Tidal Energy Demonstration Facility

Final for submission

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Project Number:

107405

Date:

June 10, 2009

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This Statement of Qualifications and Limitations is attached to and forms part of the Report.

Executive Summary

The Fundy Ocean Research Centre for Energy proposes to construct, operate and decommission a Tidal Energy Demonstration Facility in the Minas Passage, near Parrsboro, Nova Scotia.

The objectives of the Demonstration Facility are:

- To build and operate a tidal energy Demonstration Facility to test the commercial potential of in-stream tidal energy devices designed to convert tidal kinetic energy to electrical energy;
- To acquire information necessary to assess the performance of tidal energy devices including their effect on the environment and the effect of the environment on the devices; and,
- To develop monitoring techniques and methodologies for these devices in the tidal environment.

The Facility will consist of three subsea turbine generators, individual subsea cables connecting the turbines to land-based infrastructure, an onshore transformer substation, and buried power lines connecting to the local power distribution system (the Project). This Project is subject to a screening level Environmental Assessment under the *Canadian Environmental Assessment Act* and is a Class 1 Undertaking under provincial regulations. The Environmental Assessment will be reviewed jointly under the terms of the Federal-Nova Scotia Environmental Assessment Agreement.

This Environmental Assessment Document addresses the potential impacts associated with the Demonstration Project only, and relates to the deployment of three turbine generators. It does not address or predict the impacts of a larger array of turbine generators or a commercialization level project, as these projects would require a separate Environmental Assessment process. It is anticipated that some of the information gained from the environmental effects monitoring for the Demonstration Project can be used by researchers to model and predict potential impacts of scaled-up developments.

The demonstration turbines will be located within a Crown Lease on the seabed in the vicinity of Black Rock on the north side of the Minas Passage, approximately 1.25 km from shore. The generators (with the possible exception of the Minas Basin Pulp and Power/Marine Current Turbines unit) will be installed on gravity bases, rather than drilled foundations. The units will be installed on the seabed in approximately 30 - 45 m depth at low tide.

The Clean Current 2.2 MW model is approximately 18 m in length and has an outside diameter of approximately 20 m. The Nova Scotia Power/OpenHydro turbine is rated to 1 MW and the total diameter is 10 m with a 4 m diameter open centre. The MBP&P/Marine Current Turbine unit is 1.0 - 1.2 MW and will consist of twin axial flow rotors approximately 15 m in diameter. The MCT turbine will either be mounted on a steel gravity based structure or steel pin pile foundations in the seabed. A visible portion of the turbine's support structure will project approximately 21.5 m above the sea surface at low tide. The total capacity of the three devices together will be approximately 4.4 MW.

The Crown Lease will also include a 1.25 km long cable corridor connecting the generators to a land based facility above the high water mark. The terrestrial facility will be built on land leased from a private landowner and will consist of an underground vault to receive the submarine cables, a small building housing electrical switchgear and an interpretive centre, a parking area, a transformer substation and an underground cable connection to the power lines along West Bay Road.

Deployment of the NSPI/OpenHydro turbine is scheduled for October, 2009 when construction of the onshore electrical facility will also begin. The onshore facility is expected to be connected to the electrical

grid by summer 2010. Installation of the subsea cables is planned for late summer of 2010, and this will be combined with or followed shortly by installation of the two remaining turbines, which will be completed by mid-summer, 2011. The demonstration turbines will operate for one to four years, following which the turbines and their gravity bases will be removed.

Emissions and discharges are expected to be similar those associated with other marine and small terrestrial construction projects. Electromagnetic fields and noise associated with the turbines are less well understood and will require additional monitoring. Preliminary information suggests these emissions will have negligible impact due to the limited scale demonstration facility.

Studies undertaken in 2008 to characterise the sea bed included the use of high-resolution seismic reflection systems, sidescan sonar, multibeam bathymetric sonar and photographic surveys. For the most part, the deployment area consists of exposed and scoured volcanic and sedimentary bedrock with course gravel and boulders covering glacial-era muds that may remain between upturned sedimentary ridges. Moving toward shore, thick surficial sediments overlie the bedrock. The cable route has been selected to avoid areas of slump and regions of gravel bedforms.

Currents were measured over the lunar month using bottom mounted instruments three times at three different sites around the deployment area. The mean speed, mean velocity and maximum current speeds with the corresponding directions at specific water depths were measured at each site.

Information on benthic animal and seaweed communities was obtained from seabed video and still camera photography in August and September 2008, as well as from several bottom samples obtained by scallop dredge in August 2008. Four main types of benthic communities are described based on the substrate they inhabit. Benthic communities exhibit moderate diversity and abundance of organisms reflective of communities adapted to the particular environment at the Project site.

The Minas Passage/Minas Channel supports small commercial fisheries which tend to be fished from nearby. Inner Bay fisheries comprise primarily lobster, herring and soft-shell clams; however, many species in the Outer Bay also move in and out of the Inner Bays, and the Inner Bay may be an important nursery area for many species. Most lobster fishing takes place along the Blomidon, Scots Bay and Parrsboro shores, and is concentrated nearshore although traps are occasionally set in deeper, high current areas. Eleven lobster boats routinely fish in the Minas Channel/Passage (part of LFA 35) although considerably fewer are known to fish in the Project area.

There are no First Nations reserves in or immediately surrounding the Project area. The Fort Folly First Nation in Dorchester, New Brunswick operates commercial fishing vessels from Parrsboro Harbour. A Mi'kmaq Ecological Knowledge Study (MEKS) has been commissioned for completion by August 2009, and is jointly funded by FORCE and the province of Nova Scotia.

The largest and most frequent commercial vessels moving through the Minas Channel/Passage are exclusively gypsum bulk carriers with a maximum draft of 10 m when fully loaded, sailing at high tide or falling high tide. Gypsum vessels sail through the deepest part of the Minas Passage generally tending to the Cape Split (southern) side. The closest the shipping route approaches the edge of the Demonstration Deployment Area is 1 km.

A scoping exercise was undertaken to identify an appropriate list of Valued Ecosystem Components (VECs) upon which to focus the assessment. VECS were established based on a review of the Strategic Environmental Assessment Report and supporting Background Report, formal and informal discussions with provincial/federal regulatory agencies and government scientific authorities, a review of listed species and species at risk found within the Project area, discussions with stakeholders and First Nation/Aboriginal groups and the professional judgment of the Proponent's Study Team. Following this process, the following VECs were retained for detailed analysis.

• Marine Benthos	• Intertidal Environment
• Marine Fish and Water Quality	• Terrestrial Species at Risk
• Marine Mammals	• Recreational and Commercial Fishing
• Marine Birds	• Archaeological and Heritage Resources
• Marine Species at Risk	• Tourism and Recreation
• Terrestrial Wildlife and Wildlife Habitat	

Each of the VECs was evaluated for potential interactions between the VEC and Project activities during all project phases as well as malfunctions or accidents that may occur. These interactions were evaluated for potential significance after application of technically and economically feasible mitigative measures. The cumulative effects of the proposed Demonstration Facility in conjunction with past, present and likely future projects were also evaluated. Environmental monitoring and follow-up measures are proposed and will be undertaken to ensure compliance with applicable regulations, standards and guidelines, to verify environmental effect predictions and refine mitigative measures, as well as to gather important information to further evaluate the potential for environmental effects for future larger scale tidal energy projects (*i.e.,* commercialization).

With the implementation of the proposed mitigation measures including development and implementation of a detailed monitoring plan, adverse residual environmental effects of the Project are predicted to be not significant for all VECs. A positive effect is anticipated for recreation and tourism given the potential for an increase in ecotourism.

The Project will contribute to the goals established in the Provinces' Renewable Energy Standards for the reduction of GHGs and dependence on fossil fuels for generating electricity. In addition, a demonstration project of this nature is required and has been recommended in the Strategic Environmental Assessment and the Background Report to gather valuable and much needed information to fully assess the potential environmental effects of tidal energy and tidal in-stream energy conversion technology as a renewable commercial energy source in the Bay of Fundy.

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Acronym List

ACCDC – Atlantic Canada Conservation Data Centre
ACOA – Atlantic Canada Opportunities Agency
ADCP - Acoustic Doppler Current Profiler
AECOM - Architecture, Engineering, Consulting, Operations and Maintenance
AGS – Atlantic Geosciences Society
AQI – Air Quality Index
BC – British Columbia
BMP – Best Management Practice
BP – Years Before the Present
CCG – Canadian Coast Guard
CEAA – Canadian Environmental Assessment Act
CIS – Canadian Ice Service
COSEWIC – Committee on the Status of Endangered Wildlife in Canada
CWS – Canadian Wildlife Service
dB – Decibels
DFO – Fisheries and Oceans Canada
EA – Environmental Assessment
EC – Environment Canada
ECM – Environmental Compliance Monitoring
EEM – Environmental Effects Monitoring
EGSPA – Environmental Goals and Sustainable Prosperity Act
EMEC - European Marine Energy Centre
EMFs – Electromagnetic Fields
EMP – Environmental Management Plan
FCR – Regulations Respecting the Coordination by Federal Authorities of Environmental Assessment Procedures and Requirements
FEAC – Federal Environmental Assessment Coordinator
FMG – Bay of Fundy, Gulf of Maine and Georges Bank Regional Ecosystem
FN – First Nation
FORCE – Fundy Ocean Research Centre for Energy (the Proponent)
Fundy MCTS – Fundy Marine Communication and Traffic Services Centre
GBS – Gravity Base Structure
GHG – Green House Gas
ha - Hectares
HADD – Harmful Alteration Disruption or Destruction
HRDC – Human Resources Development Canada
Hz - Hertz
IT – International Telecom
kHz - Kilohertz
km/h – Kilometres Per Hour
kV - Kilovolt

kVac - Kilovolt Alternating Current
Lat - Latitude
LCE – Linear Cable Engine
LFA – Lobster Fishing Area
Lon - Longitude
m/s – Meters Per Second
MB – Multibeam
MBCA – Migratory Birds Convention Act
MBP&P – Minas Basin Pulp and Power
MCT – Marine Current Turbine
MEKS – Mi'kmaq Ecological Knowledge Study
mg/L – Milligrams Per Litre
MODU – Mobile Offshore Drilling Unit
MSDS – Materials Safety Data Sheets
MT – Metric tonnes
MVA - Megavolt Amperes
MW - Megawatts
MWL – Mean Low Water
NB – New Brunswick
NEB – National Energy Board
NMFS – National Marine Fisheries Service
NRCAN – Natural Resources Canada
NS – Nova Scotia
NSE – Nova Scotia Environment
NS*EA* – Nova Scotia *Environment Act*
NSDNR – Nova Scotia Department of Natural Resources
NSDTCH – Nova Scotia Department of Tourism, Culture and Heritage
NSPI – Nova Scotia Power Incorporated
NWPA – Navigable Waters Protection Act
OEER – Offshore Energy Environmental Research Association
OIC – Officer In Charge
OWTG – Offshore Waste Treatment Guidelines
PID – Property Identification Number
$PM_{2.5}$ - Fine Particulate Matter
PM - Particulate Matter
POL – Petroleum, Oils and Lubricants
ppt – Parts Per Thousand
RA – Responsible Authority
RFP – Request for Proposals
rpm – Rotations Per Minute
SAR – Species at Risk
SARA – Species at Risk Act
SBM – Synthetic-based Muds
SCADA - Supervisory Control and Data Acquisition

SDTC – Sustainable Development Technology Canada
SEA – Strategic Environmental Assessment
SH – Shell Height
SO_2 - Sulphur Dioxide
SPA – Scallop Production Area
TAC – Total Allowable Catch
TISEC – Tidal In-Stream Energy Conversion
TRS – Total Reduced Sulphur
VEC – Valued Environmental Component
VOCs - Volatile Organic Compounds
WBM – Water-based Muds
WHMIS – Workplace Hazardous Materials Information System
WMP – Waste Management Plan

1. Introduction

The Fundy Ocean Research Centre for Energy (FORCE; the Proponent) proposes to construct, operate and decommission a Tidal Energy Demonstration Facility in the Minas Passage, near Parrsboro, Nova Scotia (Figure 1-1 Project Location; Figure 1-2 Aerial View). In general terms, the facility will consist of multiple subsea turbine generators, subsea cables connecting the turbines to land-based infrastructure, an onshore transformer substation, and buried power lines connecting to the local power distribution system (the Project). This Project is subject to federal and provincial environmental approval under the *Canadian Environmental Assessment Act* (*CEAA*) and Nova Scotia *Environment Act* and Environmental Assessment Regulations. This document has been prepared to meet the requirements of a federal Screening Level environmental assessment pursuant to *CEAA* and a Class 1 Undertaking pursuant to the provincial regulations.

This document does not address or consider a larger array of TISEC devices or a commercialization level project, as these projects would require a separate Environmental Assessment process.

1.1 Study Background and Objectives

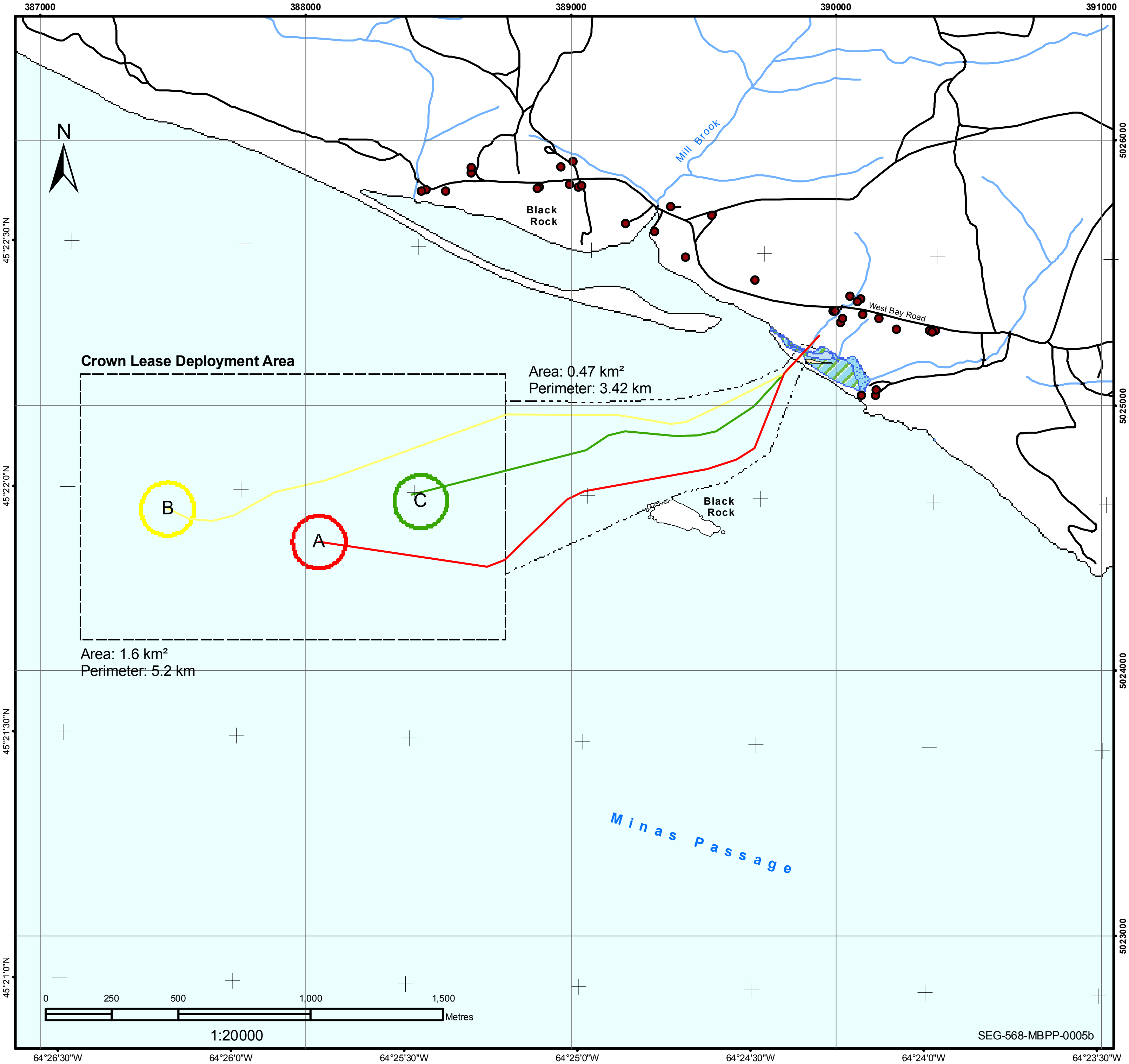
With growing global concerns regarding climate change and energy security along with developing technology in tidal energy, there is an urgent interest in harnessing tidal power. In 2007, the Nova Scotia Government passed the *Environmental Goals and Sustainable Prosperity Act* (*EGSPA*), which among other caps, calls for a reduction of greenhouse gas (GHG) of 10% below 1990 levels by the year 2020. In addition, Nova Scotia has legislated Renewable Energy Standards which will require up to 500 megawatts of new renewable energy capacity to be added to the system by 2013.

In 2007, the Province of Nova Scotia funded a Strategic Environmental Assessment (SEA) to facilitate the development of tidal energy projects within the Bay of Fundy. The SEA was supported by a background study entitled Background Report for the Fundy Tidal Energy Strategic Environmental Assessment which was prepared by a consulting team lead by Jacques Whitford Limited (Jacques Whitford *et al.* 2008).

The SEA Report was completed and submitted in April 2008 and included a number or recommendations to guide a strategic approach to the development of marine renewable energy in the Bay of Fundy. Both the Background Report and the SEA were made available for public comment. Community forums were held in the spring of 2008 both to inform the public and to gather feedback on the work and studies completed. The Nova Scotia Minister of Energy subsequently responded to recommendations in the SEA report. Of particular relevance is Recommendation 2 which states that the "*OEER recommends that the Province of Nova Scotia give the necessary approvals, contingent on satisfactory completion of a project-specific environmental assessment, to allow demonstration of a range of TISEC technologies in the Bay of Fundy*" (OEER 2008). The Minister has indicated support of the demonstration facility of the TISEC technology pending a specific environmental assessment.

In August 2007 concurrent with the SEA, the Province issued a request for proposals (RFP) for the design and construction of a Tidal Energy Demonstration Facility (the Facility) to demonstrate Tidal In-stream Energy Conversion (TISEC) technology. Minas Basin Pulp and Power (MBP&P) was successful in the RFP process and has been involved in the planning and design phase for the Tidal Energy Demonstration Facility.

In addition to the RFP for the design and construction of the Facility, the Province also issued an RFP for TISEC technologies to be tested at the Facility.



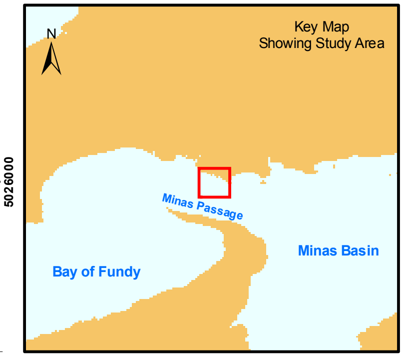


Figure 1-1 Project Location Fundy Tidal Energy Demonstration Facitiy

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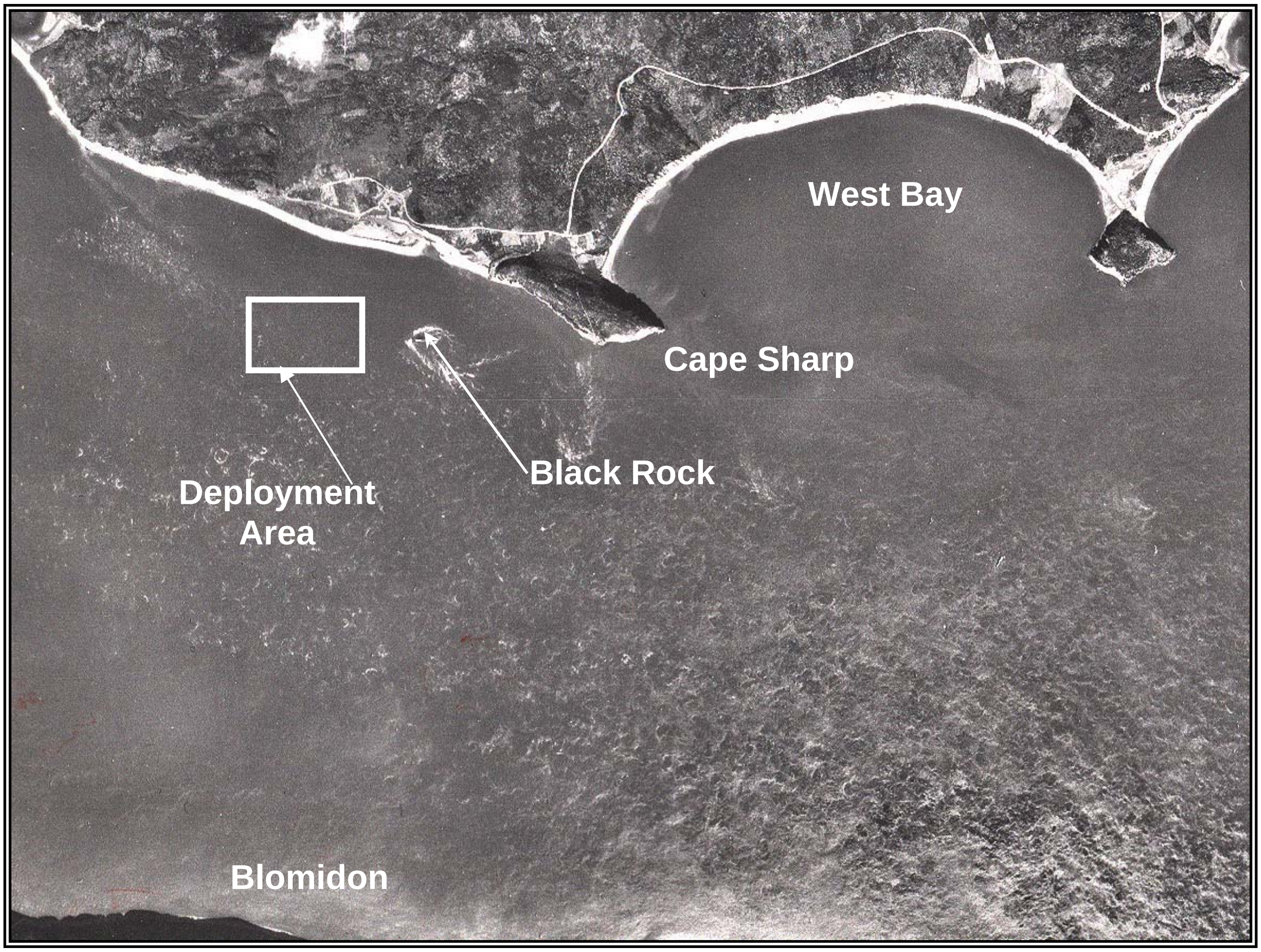

Figure 1-2: Aerial View of the Deployment Area
Source: NAPL Reproduction Centre – Energy Mines and Resources, Government of Canada
Photo # 21, Flight Line A-21330

The Province has since concluded agreements with three companies:

- Minas Basin Pulp and Power (in partnership with Marine Current Turbines);
- Nova Scotia Power Inc. (NSPI) in partnership with OpenHydro; and,
- Clean Current.

The successful bidders (pending the required permitting and approvals) will be permitted to demonstrate their technologies for a minimum of 12 months and a maximum of three to four years. The maximum combined electricity output of the demonstration facility is approximately 4.4 megawatts (MW).

The main objectives of the Demonstration Facility are:

- To build, own and operate a tidal energy Demonstration Facility in Nova Scotia to test and demonstrate in stream tidal energy devices designed to convert tidal kinetic energy to electrical energy;
- To acquire information and knowledge necessary to assess the performance of tidal energy devices including their effect on the environment and the effect of the environment on the devices; and,
- To develop monitoring techniques and methodologies for TISEC devices in the tidal environment.

It is important to underline that the main objective of FORCE is to demonstrate technology rather than to sell electrical power. Any revenue obtained from the sale of power generated by the devices will be used to offset operating costs and/or financial obligations of FORCE.

1.2 Purpose and Need for the Project

The Demonstration Facility is one step in responding to the Province's Renewable Energy Standards which require the addition of new renewable energy capacity as part of Nova Scotia's plan to reduce GHGs and dependence on fossil fuels for generating electricity. The Province intends to have renewable energy sources meet approximately 20% of its electrical energy requirements by 2013.

The SEA process undertaken by the Province recommended that TISEC technology be considered in phases; that is, test the technology at a pilot and demonstration level prior to developing or commercializing the technology in the Bay of Fundy environment. Furthermore, the SEA recommended monitoring and assessment, where possible, of the effects of TISEC devices on the environment. Demonstration, monitoring, and assessment will determine if the technology is viable as a renewable energy source for Nova Scotia.

1.3 Proponent Information

The Fundy Ocean Research Centre for Energy (FORCE) is the named proponent for the Project. It should be noted that Minas Basin Pulp and Power Co. Ltd. was initially considered the named proponent for the Project until such time as a non-profit corporation could be established to manage the Demonstration Facility. The non-profit corporation, FORCE, has since been established. At this time, the sole member of the board of directors of FORCE is Minas Basin; however, other members will include a representative from each of the turbine device owners and a representative from the Department of Energy.

Although FORCE is the named proponent for the Project for the purpose of the EA, FORCE will be responsible for the installation and maintenance of the common infrastructure only (*i.e.,* the cable and the land-based infrastructure). Each turbine device owner will be responsible for the installation, operation, and decommissioning of their respective devices. This separation of responsibility is considered necessary in order to appropriately manage any liability associated with the project.

The principal contact for the development and operation of the proposed Facility is:

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AECOM (formerly Gartner Lee Ltd.) has been engaged to prepare and/or provide support in the preparation of environmental approvals and permits, including the environmental assessment. The following individuals have been involved with the Project:

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1.4 Regulatory Framework

The Project is subject to numerous federal and provincial laws, regulations and guidelines. The Project must be registered as a Class 1 Undertaking (*i.e.,* more than 2 MW production rating derived from tides) pursuant to the Nova Scotia *Environment Act* and Environmental Assessment Regulations. The Project is also subject to approval pursuant to *CEAA* as a screening level assessment (*i.e.,* less than 5 MW production rating). The following sections provide context for the regulatory requirements of the Project. While this is not intended to be an exhaustive list of pertinent federal and provincial legislation and policies, it does provide an overview of key regulatory considerations for Project planning and implementation.

1.4.1 Federal Legislation

In accordance with the Regulations Respecting the Coordination by Federal Authorities of Environmental Assessment Procedures and Requirements (*i.e.,* FCR process), a Project Description Document was prepared and distributed to the CEA Agency and subsequently to the various federal departments and agencies that may have a responsibility or interest in the proposed Project. Transport Canada, Fisheries and Oceans Canada, and Environment Canada have indicated that they would be Responsible Authorities under *CEAA* as per the following potential triggers:

- Transport Canada would require an environmental screening given the likely requirement of a permit under Section 5 of the *Navigable Waters Protection Act* (*NWPA*);
- Fisheries and Oceans Canada (DFO) would require an environmental screening given the likely requirement for an authorization pursuant to Section 35(2) of the *Fisheries Act* for the harmful alteration, disruption, or destruction of fish habitat and potentially an authorization pursuant to Section 32 of the *Fisheries Act* for the destruction of fish; and,
- Initially, Environment Canada identified itself as a Responsible Authority requiring an environmental screening given the potential requirement for an Ocean Disposal Permit under Section 127(1) of the *Canadian Environmental Protection Act* for the disposal at sea of any dredged material. However, based on recent clarification that no dredging or levelling will be required for the deployment of the turbines, Environment Canada will not be a Responsible Authority but rather an Expert Department.

Since this is a multi-jurisdictional assessment, all parties have agreed that the CEA Agency would serve as the Federal Environmental Assessment Coordinator (FEAC) for the Project. In addition to the federal legislation indicated above, the following legislation is relevant to the Project:

- The *Migratory Birds Convention Act* (*MBCA*) protects migratory bird species and states that “no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird” without a permit. Section 35 of the Migratory Birds Regulations prohibits the deposit of oil, oil wastes or other substances harmful to migratory birds in any waters or any area frequented by migratory birds.
- The *Species at Risk Act* (*SARA*) protects wildlife species from becoming extinct through prohibitions against killing, harming, harassing, capturing or taking species at risk, and against destroying their critical habitats. Management of species at risk and of special concern (as identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)) is accomplished by providing for the recovery of species at risk due to human activity and by ensuring that species of special concern don’t become endangered or threatened through sound management.
- It should be noted that in the event that federal funding is awarded for development of the Project (see discussion below), the Federal Policy on Wetland Conservation will immediately apply. As such, the Canadian Wildlife Service (CWS) of Environment Canada will be included in consultations along with NSDNR and NSE regarding wetland compensation and monitoring.

To date, no federal funding has been received in support of this Project. Efforts are continuing to obtain financial support from Sustainable Development Technology Canada (SDTC), Natural Resources Canada (NRCAN), Human Resources Development Canada (HRDC) and the Atlantic Canada Opportunities Agency (ACOA). Although FORCE has not received federal funding to date, both NSPI and Clean Current received funding from SDTC in 2006 for the development and demonstration of their clean technologies.

FORCE plans to apply to ACOA’s Community Adjustment Fund for a contribution to site improvements, such as the building, roads, signage, and cable vault. Also, FORCE plans to apply for funding under the Canada Clean Energy Fund, recently announced by the Government of Canada. It is believed that significant elements of the Project such as the submarine cables, monitoring program and equipment, and transmission lines are eligible.

1.4.2 Provincial Legislation

The Nova Scotia *Environment Act* (NS*EA*) promotes protection and prudent use of the environment. All provincial and federal departments, agencies, boards and commissions and the general public are subject to prosecution, ministerial orders and other remedies under the *Act*. A number of regulations have been passed under the *Environment Act* to help deal with its practical application. Regulations most relevant to this Project include: Environmental Assessment Regulations and the Activities Designation Regulations.

Under the Activities Designation Regulations, a Water Approval is required for watercourse alteration activities proposed during the construction phase (*e.g.,* cable crossing of a stream). Also requiring a water approval under the Activities Designation Regulations is the alteration of any wetland.

In addition to permits required pursuant to the *Environment Act*, a permit pursuant to the *Beaches Act* and Beaches Regulations is required for the installation of the cable across the beach. This legislation is administered by Nova Scotia Department of Natural Resources (NSDNR).

In addition to the *Environment Act* and Regulations, other relevant provincial laws include, but are not limited to: the *Crown Lands Act*; *Occupational Health and Safety Act*; *Special Places Protection Act*; *Endangered Species Act* and *Wildlife Act*.

The Nova Scotia government has allocated $7 million to the Demonstration Project from the EcoNS fund (formerly EcoTrust). EcoNS is a trust fund set up by the Province to administer money transferred by the government of Canada to provinces and territories to be used to fund projects that, among other things, reduce greenhouse gas emissions. Of the $7 million, approximately $100,000 has been spent on research, another $100,000 on consultant's fees, and $200,000 advanced to MBP&P as a contribution to regulatory and start-up costs. The balance will be available to FORCE in accordance with a payment schedule awaiting ministerial approval.

1.4.3 Joint Federal/Provincial EA Review

Section 47 of the NS*EA* also allows for joint assessments with the federal government; in fact the province and federal government have already established a joint federal-provincial committee to coordinate agency input for the Project. Since the Project triggered both federal and provincial environmental assessment legislation, the federal and provincial regulators have agreed to review the proposal jointly. It should be noted that the federal and provincial governments will each make their decisions on matters within their own legislated authorities. While the objective is to produce a single document to address the environmental assessment requirements of both the NS*EA* and *CEAA*, it is recognized that there are differences in the scope of the Project. For the purposes of *CEAA*, the scope of the Project to be assessed will be focused on the construction, operation, maintenance, decommissioning, as well as the associated follow-up of the marine components subject to federal approvals/authorizations.

The joint assessment process and associated timelines for decisions are identified in the Draft Federal-Nova Scotia Environmental Assessment Agreement (Appendix 1). The timeline for a decision was agreed as 90 days from the date of the registration of the Environmental Assessment Registration Document to the Nova Scotia Department of the Environment.

1.4.4 Municipal Considerations

Discussions with the Municipality of the County of Cumberland regarding the construction of onshore facilities indicate that no zoning issues are anticipated. All permits associated with the construction and operation of the building will be made to the appropriate to municipal departments (Building Permit) and provincial departments (*i.e.,* septic field, potable water well).

1.5 Organization of the Report

This Environmental Assessment (EA) Report is organized to reflect the process by which the assessment has been conducted. Section 1.0 introduces the proponent and the undertaking and provides background information on the Project.

Section 2.0 describes the proposed undertaking. Project activities are discussed as well as the location, scope and schedule for the Project. Emissions and discharges and potential malfunctions and accidental events that may arise during construction, operation and decommissioning of the Project are described.

Section 3.0 describes the existing physical, terrestrial, marine and socioeconomic characteristics of the study area.

A description of the environmental assessment methodology employed for this assessment is provided in Section 4.0 along with the scope of the assessment.

Section 5.0 provides a description of the community and regulatory consultation efforts as well as the Aboriginal engagement.

Section 6.0 provides the results of the environmental effects assessment for valued environmental components (VECs).

Section 7.0 discusses potential malfunctions and accidental events (along with their potential environmental effects and proposed mitigative measures), which could occur during construction, operation, and decommissioning of the Project.

Section 8.0 describes potential cumulative environmental effects of the Project considered in conjunction with past, present and likely future projects in the study area.

Section 9.0 discusses the effects of the local environment on Project components and activities.

A summary of the EA Report and conclusions from the EA are presented in Section 10.0. Section 11.0 details literature and personal communications cited in the report.

A series of technical reports and other supporting information is contained in the appendices to this document.

2. Project Description

2.1 Project Overview

The proposed Tidal Energy Demonstration Facility generally consists of three turbine generators on the seabed connected to a land-based transformer substation via subsea cables. The land-based facility will be connected to the existing local power grid. The Facility is designed to operate as a demonstration to confirm the commercial viability of the technology and to assess the effects of the devices on the environment as well as the effects of the environment on the devices.

2.2 Project Location

The demonstration turbines will be located on the seabed in Minas Passage in the vicinity of Black Rock (west of Cape Sharp) on the Parrsboro (*i.e.,* north side) of the Passage (Figure 1-1). The three turbines will be located due west of Black Rock, approximately 1.25 km from the shoreline and will be installed on the seabed in approximately 30 - 45 m depth at low tide.

Within the Passage, a Crown Lease deployment area has been proposed within which the three turbines will be located. The area measures approximately 1.0 km by 1.6 km. An application for the Crown Lease has been filed with NSDNR. The coordinates of the deployment area are provided in Table 2-1.

Table 2-1 Crown Lease Deployment Area Coordinates

Vertex	Easting	Northing	Lon	Lat
1	387150	5025121	-64.441	45.371
2	388749	5025121	-64.421	45.371
3	388749	5024121	-64.420	45.362
4	387150	5024121	-64.441	45.362

Within the deployment area, three berths have been identified, each with a radius of 200 m (Figure 1-1). The coordinates of the three berths are provided in Table 2-2. These locations are approximate and may move slightly during micro-siting and TISEC placement by the device owners.

Table 2-2 Turbine Berth Area Coordinates

Site	Easting	Northing	Lon	Lat
A	388049.304	5024489.1	-64.429524	45.364969
B	387478.903	5024613.23	-64.436834	45.365995
C	388432.206	5024641.96	-64.424671	45.366406

In addition to the Crown Lease deployment area, a subsea cable corridor approximately 1.25 km in length to the eastern edge of the Crown Lease area, and 200 m to 650 m wide, has been identified to connect the turbine devices to the land-based facility. A wide corridor has been proposed to allow sufficient room for vessel movement during installation and operation as well as to provide for the flexibility to avoid seafloor obstacles when laying the cables. Approaching the intertidal zone, the corridor will narrow to 200 m for the remainder of the distance to the land-based facility (Figure 1-1).

The onshore facility is proposed for a portion of Lot 84-PM (PID 25347451), in the Municipality of the County of Cumberland. The portion of the lot to be used for the Project has a total area of approximately 2 ha (20,000 m^2) and is owned by L. Pelletier. Based on discussions with officials of the Municipality of the County of Cumberland, the lot is currently zoned G (general) and as such, no change in zoning is expected for proposed use as an electrical facility.

The substation/onshore facility and parking area will be situated on the leased parcel of land. The parking lot and access road will occupy approximately 0.11 ha (1,115 m^2) and the building is expected to have a footprint of approximately 0.023 ha (230 m^2) for a total of approximately 0.133 ha (1,330 m^2).

The connection to the local power utility distribution system will be via a 25 kilovolt (kV) buried power line providing a connection to the nearest local 25 kV distribution circuit, which is located approximately 100 m from the intended location of the onshore electrical facility. NSPI will be responsible for the connection from the existing circuit to the substation of the onshore facility.

Once the deployment site was located, the location of the land-based facilities was selected. This was done in consideration of proximity to the offshore site, shoreline topography and terrain, proximity to existing electrical power transmission lines on-land, and availability of land/negotiations with landowners. To the west (towards the community of Black Rock) of the selected landfall site, there is a large and long sand spit, including large wetlands areas and steep rock embankments which would make cable installation difficult and costly and with greater potential for environmental effects to the surrounding ecosystem. As well, immediately east of the selected landfall site, the cable route would cross over a pond and a wider area of wetland habitat. Further to the east is Cape Sharp, a steep sided volcanic structure consisting of very hard exposed bedrock that would prevent the installation of cables near or at that important topographical feature.

Once the location of the land-based facilities was identified, a cable corridor to connect the land and marine sites was identified. Corridor selection considered environmental constraints (*e.g.,* salt marsh habitat), technical constraints and features (*e.g.,* flexibility of the cable, natural crevices along the sea floor, moving gravel bedforms and slumps), and constructability issues (*e.g.,* requirements for vessel and equipment set-up). The cable corridor, as shown in Figure 2-5, was chosen to cross the narrowest part of the salt marsh/wetland area, passing under an existing stream. The affected wetland area is estimated to be less than 200 m^2. Although not all wetland habitat could be avoided, the affected area is minimized and the appropriate protection measures will be used to minimize impacts on the wetlands and a wetland compensation plan will be developed, as required, in consultation with NSE and NSDNR and other regulatory agencies as appropriate (*i.e.,* Environment Canada).

2.3 Project Components

The four main components of the Project are:

- The subsea turbine generator devices;
- The subsea cable;
- The land-based transformer substation; and
- The buried power lines connecting to the existing distribution system.

The main components are described in the following sections.

2.3.1 Turbine Generators

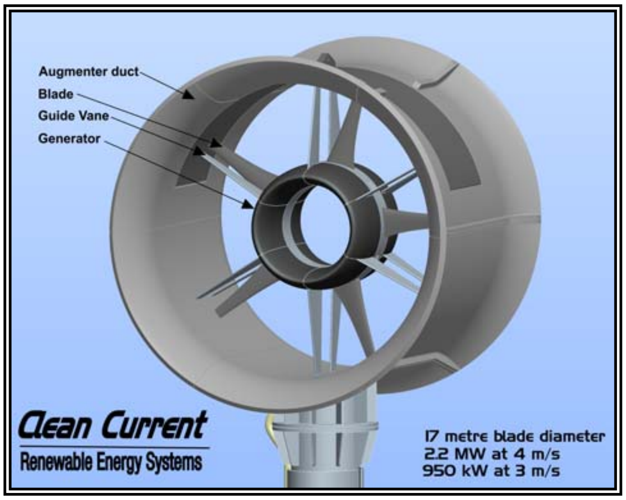
As previously indicated, three companies have been selected to demonstrate TISEC technology at the Facility. Each company will deploy a single turbine mounted on a steel “gravity based structure” (GBS) with ballast specifically designed for each unit. In the case of the Marine Current Turbine (MCT), specific details regarding installation are not yet finalized; the turbine will either be mounted on a steel GBS or a pin pile foundation set into sockets drilled to suitable bearing strata in the seabed. In all instances, the GBSs or pile foundations will be designed to be removable upon completion of the demonstration. The total capacity of the three devices together will be approximately 4.4 MW. The various devices are described below.

All three device types have operated in pilot test situations using smaller models of lower electrical capacity. The device manufacturers report that there have been no indications of negative impacts to fish and sea mammals; however, these claims are based on somewhat limited environmental effects monitoring conducted to date. The lack of impacts is believed to be attributed to the slowly rotating blades, blade shrouds and possibly the low noise level emitted by the devices during operation. According to the device suppliers, impacts to fish and marine mammals at the Demonstration Facility are expected to be minimal since certain marine mammals and fish reportedly tend to avoid high current areas, and those that frequent high currents have excellent perception and agility, and will avoid large fixed objects. In addition, marine plant density is low in deep water high current areas (as confirmed by underwater photography collected during 2008) and so there are limited feeding opportunities in these scoured bedrock areas. As an example, Clean Current has continuously operated a turbine at Race Rocks, BC for a period of 9 months. During this time, no adverse effects were noted by the Race Rocks caretaker or the diving staff at Pearson College (Archipelago Marine Research 2006).

A key part of this Demonstration Project is to document environmental impacts, if any. To this end, a detailed environmental effects monitoring strategy will be developed through collaboration with device owners and the regulatory agencies. It is recognized that an adaptive management approach will be required to develop and effective monitoring program in the harsh Minas Passage marine environment.

The **Clean Current** turbine is a bi-directional horizontal axis turbine with a direct drive variable speed permanent magnet generator (illustrated below). Tidal currents cause the high-efficiency hydrofoil blades to turn, thereby driving the generator. The Clean Current 2.2 MW model is designed for tidal velocities that peak at 4.5 m/s (about 9 knots). The turbine consists of an outer augmenter duct, a rotor with five blades, a hollow hub (containing the generator) supported by guide vanes, and a supporting structure which attaches to the GBS.

FIGURE 2-1 CLEAN CURRENT TURBINE



The device is approximately 18 m in length and has an outside diameter of approximately 20 m. The turbine is designed to be deployed in water depths ranging from 45 - 60 m (refer to Appendix 2: Plans and Scaled Drawings). Clean Current has selected Site B, which is approximately 45 m below low tide water level (Figure 1-1).

The GBS and turbine combined weighs approximately 630 tonnes. The GBS dimensions will be on the order of 32 m X 32 m, but the actual footprint in contact with the seabed will be 570 m^2, and the top of the base will be 5 - 6.5 m above the seabed (Appendix 2: Plans and Scaled Drawings). The top of the Clean Current turbine is expected to remain between 10 to 15 m below the surface at low tide.

The blades spin slowly (*i.e.,* 10 to 18 rpm) and will emit a low buzzing sound that is anticipated to help deter fish and mammals from approaching the unit. The unit is designed to prevent injury to fish or marine mammals through the use of ducts that surround the blade tips, plus a large central hole in the turbine which serves as an escape route in the event that a marine mammal swims through during operation. The ducting also attenuates noise produced by the turbine.

All required monitoring equipment will be mounted on the GBS, with the exception of the Acoustic Doppler Current Profiler (ADCP). The ADCP will be deployed separately so as to gather data that is not affected by the turbine wake.

Corrosion protection consists of a combination of sacrificial anodes as cathodic protection and a marine anticorrosion epoxy coating applied prior to deployment. No antifouling system will be used. Instead, a fouling release system consisting of a non-stick silicone based coating designed to prevent unwanted growth will be applied. Bio-fouling is anticipated to be less of an issue in the Bay of Fundy, for all of the TISEC devices, as the turbidity is higher and the units are deeper that at other sites where bio-fouling was considered to be an operational issue. At Race Rocks, BC (Archipelago Marine Research, 2006), the turbine was only 5 m below the surface such that sunlight had a strong influence on the rate of growth of marine organisms.

The **OpenHydro** open-centre turbine unit is a bi-directional, horizontal axis turbine with power takeoff through a direct drive, permanent magnet generator. It is principally comprised of a single moving part, the rotor, which is housed within the stator. The turbine is rated to 1 MW and total unit diameter is 10 m with a 4 m diameter open centre.

OpenHydro has a robust unit that requires minimal maintenance so as to better survive in the marine environment and to minimize operational costs. The design has no gearbox or other components that require regular intervention. Biofouling is not considered to be an issue for the OpenHydro unit based on previous operational experience. From an environmental perspective, a number of key design features minimize the risk to marine life:

- No requirement for lubricants when the unit is grid is connected, thereby reducing pollution risk;
- Rotor blades retained within the outer housing; and
- Large (4 m diameter) open centre which provides an exit or escape route for marine life.

The turbine will be installed directly on the seabed using OpenHydro's subsea base design (artist's impression below) which was proven at the European Marine Energy Centre (EMEC) during 2008 (photograph below). No seabed preparation is required to secure the unit to the seabed. Overturning and lateral forces acting upon the structure are resisted as a function of its own self-weight. The subsea base is a triangular gravity based structure approximately 25 m long by 21 m wide, and weighs approximately 450 tonnes (air weight). A maximum footprint area of approximately 10 m^2 will be in direct contact with the seabed, and the apex of the turbine will extend approximately 15 m above the seabed (Appendix 2: Plans and Scaled Drawings). The device is designed for peak tidal velocities of 4 m/s and to operate to a water depth of up to 80 m.

FIGURE 2-2 ARTIST'S IMPRESSION OF AN OPEN-CENTRE TURBINE MOUNTED ON A SUBSEA BASE

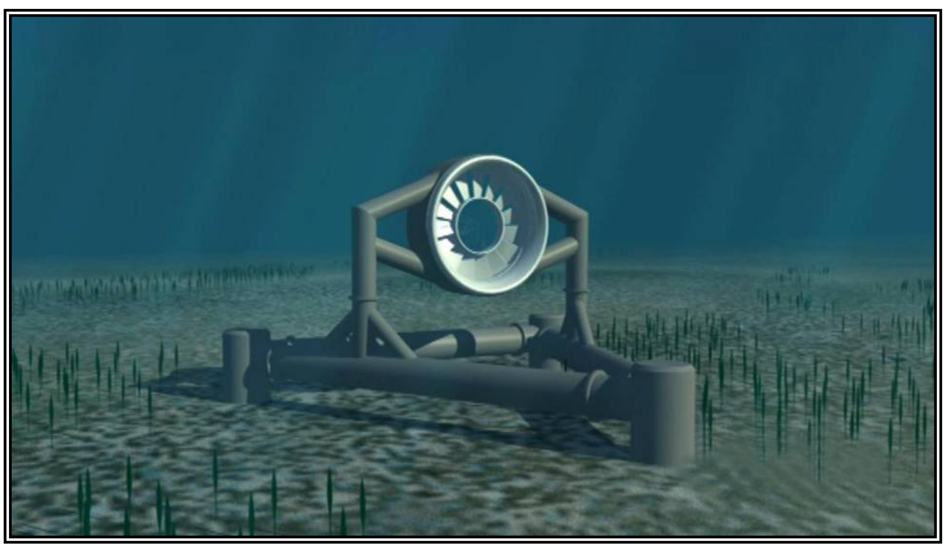
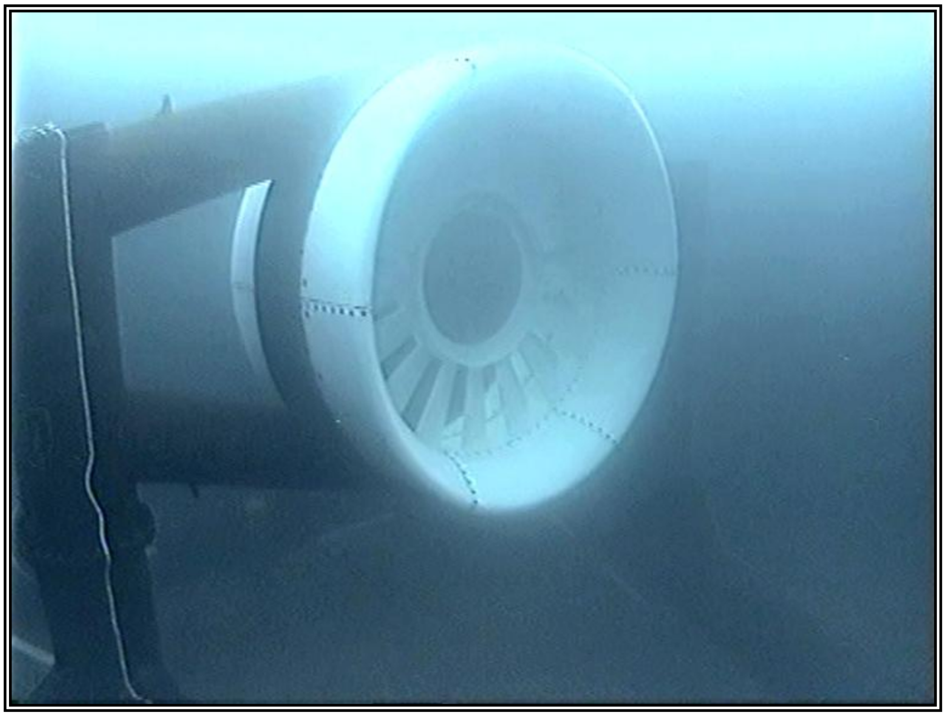


FIGURE 2-3 6 M OPEN CENTRE TURBINE ON SUBSEA BASE AT EMEC, UK



The OpenHydro turbine will be deployed at Site C, which has a water depth of approximately 40 metres at low tide. The deployment of the OpenHydro unit is currently planned for the fall of 2009, consistent with the original project schedule. This installation is the first phase of deployment and may provide some initial information on deployment challenges in the Minas Passage. Since the timescales for the power cable installation will not match this scheduled deployment, electricity generated at the turbine will be dissipated at the device. OpenHydro will dissipate heat directly from the unit itself and through use of an adjacent load bank assembly located on the gravity base. This approach will convert electrical energy into heat. Based on the characteristics associated with a 1 MW unit in currents of 3.5 m/s, the device holder estimates that the water passing by the unit will see a temperature increase of approximately 0.001 ^{0}C. Given that the heat-producing load bank will be distributed over a large area, combined with the large volume of seawater passing through and around the device during peak "heating" periods, the heating effect on seawater is anticipated to be negligible. Prior to unit connection, monitoring devices, mounted on the GBS, will be powered through the use of self contained battery packs having sufficient capacity for the life of the proposed deployment period. When the cable installation is complete (scheduled for summer 2010), the unit will be connected for the duration of the demonstration.

As indicated above, the turbine unit is designed to minimize environmental impacts and has no seals or lubricants that could potentially contaminate the environment. Because of the need to store data for a period of at least one year (in advance of cable installation), additional equipment will be required, and its protection will require use of a small amount of biodegradable oil, described in Section 2.6.3.

The turbine blades are enclosed by a shroud designed to prevent fish and sea mammals from coming into contact with the blades, while a large open centre is intended to provide safe passage for marine life. The slow rotation of the turbine (approximately 30 rpm) in combination with unrestricted access both through and around the turbine unit is not expected to create significant changes to the natural tidal velocity regime traversing the area.

The **Marine Current Turbine (MCT)** unit is the third TISEC device and is scheduled to be deployed in 2010 or later. The MCT will be in the 1.0 - 1.2 MW range, and will consist of twin axial flow rotors of approximately 15 m in diameter, each driving a generator with gearbox similar to those used in hydroelectric and wind turbines (Appendix 2: Plans and Scaled Drawings). The turbine rotor blades can be pitched through 180 degrees to allow them to operate in a bi-directional tidal flow environment. The twin units are mounted on wing-like extensions on either side of a 3 m diameter tubular steel monopole and can be raised above the sea level to enable maintenance (as illustrated below).

The MCT model is designed for tidal velocities that peak at 4.8 m/s (about 9.3 knots). As details have yet to be finalized, the turbine will likely either be mounted on a steel GBS or a "quadrapod" steel pin pile foundation set into sockets drilled to suitable bearing strata in the seabed (approximately 10 m below seabed surface). The GBS will be designed to be removable upon completion of the demonstration. In the event that a pin pile foundation is required, the piles will be cut off at seabed level and removed from the site. This will minimize seabed disruption during decommissioning.

FIGURE 2-4 MARINE CURRENT TURBINE (MCT)

Based on the present scenario for the MCT generator, there will be a visible portion of the turbine's support structure projecting above the sea surface. The surface structure will be relatively small (approximately 15 m x 15 m x 4 m) and will extend approximately 21.5 m above sea level at low tide. Figure 2-4 shows a stylized or conceptual depiction of the MCT turbine; during operation int the Minas Passage, the top of the turbine blades would be approximately 10 m below seal level at low tide rather than at surface as shown. The MCT turbine has been designed to withstand the effects of surface ice accumulation and impact on the surface piercing structure. The GBS / pile foundation and turbine combined weigh approximately 2,300 tonnes (air weight) and the seabed footprint will be on the order of 34 m^2. The GBS, if used is expected to project approximately 4.5 m above the seabed.

The blades of the MCT turbine spin slowly at approximately 12 rpm and will emit a level of noise that is anticipated to deter fish and mammals from approaching the device. All required monitoring equipment will be mounted on the monopole structure.

The turbine unit is designed to minimize environmental impacts and has no seals or lubricants that could potentially contaminate the marine environment. Vegetable based lubricants will be used and copper free anti-fouling paint will coat the GBS/piles and monopole.

2.3.2 Subsea Cables

Three separate underwater cables, each connecting one turbine generator to the onshore facility, are proposed. The submarine cable will have an outer diameter not exceeding 125 mm and will weigh approximately 32 kg per meter. The cable will be composed of three separate insulated copper power cores, each with 120 mm^2 cross sectional area, with individual copper tape shields and conductor insulation suitable for operating the power cores up to 34.5 kV alternating current. A 12-fibre optical fibre cable with multimode fibres and protective steel tubing for device control and monitoring will be included within the cable. The cable will be armoured with two layers of galvanized steel wire.

A 200 m wide subsea cable corridor has been proposed to allow the turbines to be connected to the land-based facility. This width is required to allow for the flexibility to avoid seafloor obstacles when laying the cables. As the subsea cable approaches the intertidal zone, the corridor will narrow to 50 m for the remainder of the distance to the land-based facility. Each cable will be between 2.5 km and 3.0 km in length depending on the berth location relative to onshore vault. The distance separating the cables on the seafloor may be up to 50 m to take advantage of the best cable routes. The actual combined cable footprint is relatively small (*i.e.,* 0.15 ha or 0.37 acres), given the diameter of the cables.

2.3.3 Onshore Substation

The onshore facility will consist of a building designed to house a line-up of 13.8 kV switchgear, the monitoring/SCADA equipment, and basic building services electrical equipment. The building will provide space for the device developers' power conversion equipment while an adjacent fenced area will contain the substation transformer and 25 kV switchgear and isolating switch. The onshore electrical facilities will have an overall 5/6.67 MVA power delivery capacity, designed and constructed to meet all relevant Canadian, Nova Scotia, and municipal codes and standards of design and construction. A preliminary building layout is shown on Figure 2-5.

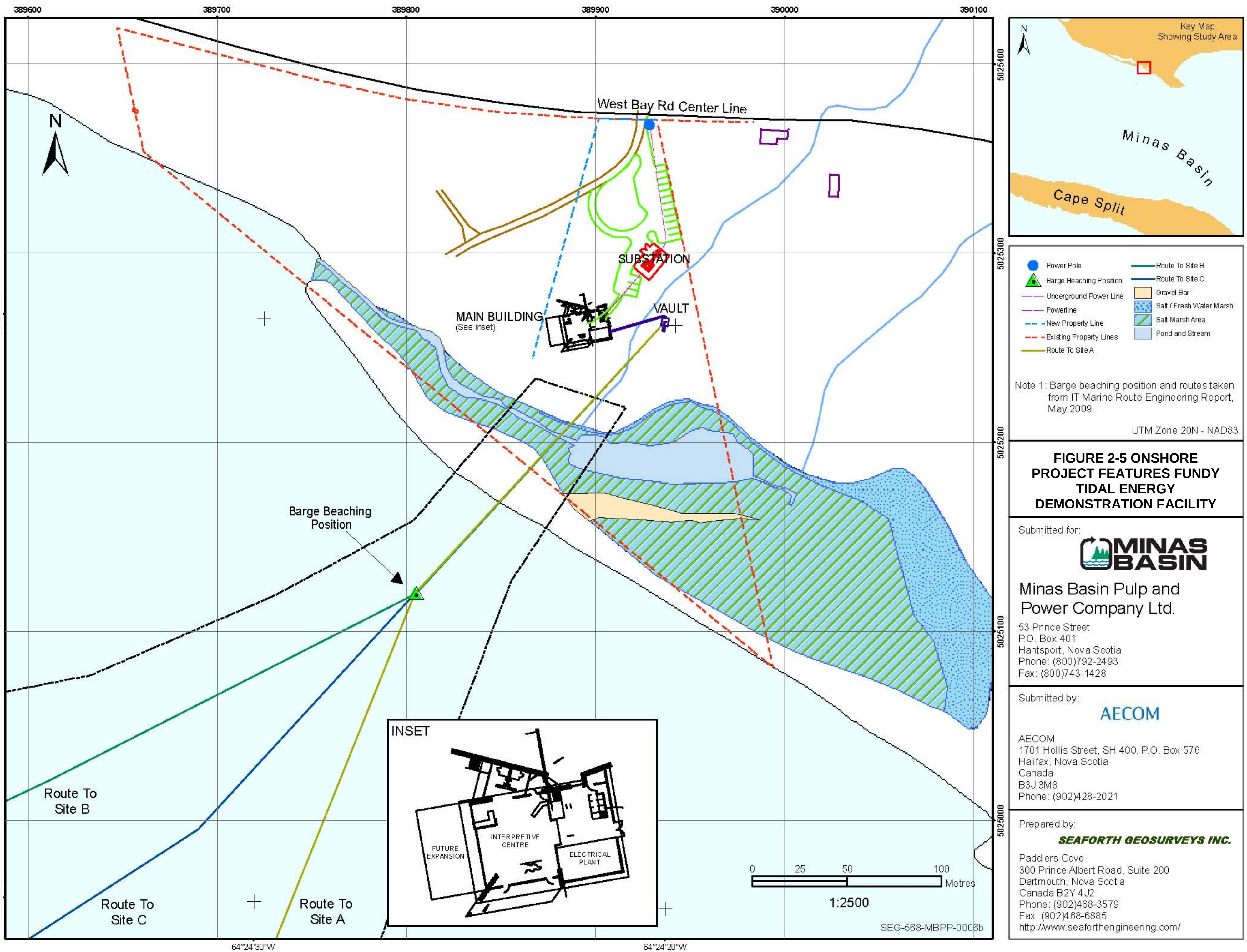


FIGURE 2-5 ONSHORE PROJECT FEATURES FUNDY TIDAL ENERGY DEMONSTRATION FACILITY

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The substation/onshore facility and parking area will be situated on the leased parcel of land (PID 25347451). The parking lot and access road will occupy approximately 0.11 ha (1,115 m^2) and the building is expected to have a footprint of approximately 0.02 ha (190 m^2) for a total of approximately 0.13 ha (1,300 m^2). The building will include green facilities and may also include an educational and interpretative center, with washrooms and related facilities, based on the availability of external funding.

2.3.4 Connection to Local Power Grid

As indicated, the connection to the local power utility distribution system will be via a 25 kV below ground connection to the nearest local 25 kV distribution circuit, which is located approximately 100 m from the intended location of the onshore electrical facility. Installation of the transmission cables will begin onshore at a below-ground cable vault (2 m X 2 m X 4 m) located to the east of the electrical facility building.

2.4 Project Activities

2.4.1 Construction Activities

2.4.1.1 Turbine Deployment

The three turbine generators will be shipped to Nova Scotia for final assembly, if required. The location within Nova Scotia for final assembly has not yet been confirmed; however, a shipyard with heavy lift and full fabrication capabilities will be required. Final assembly will take approximately three to six months. As previously indicated, the turbines will be mounted on a GBS for ease of deployment and removal, with the exception of the MCT unit which will either be mounted on a GBS or a steel pin pile foundation. The GBSs will be fabricated in Nova Scotia over a period of approximately six months. In the case of NSPI/OpenHydro, the Cherubini Metal Works of Dartmouth, Nova Scotia has been recently awarded a contract to supply the GBS and provide services for the deployment of the OpenHydro turbine (NSPI News Release 2009). Once assembled, the turbines will be secured to the GBSs and subsequently transported/towed to the respective berth locations via barge or tug. In the case of the OpenHydro Turbine, a custom deployment barge will be used.

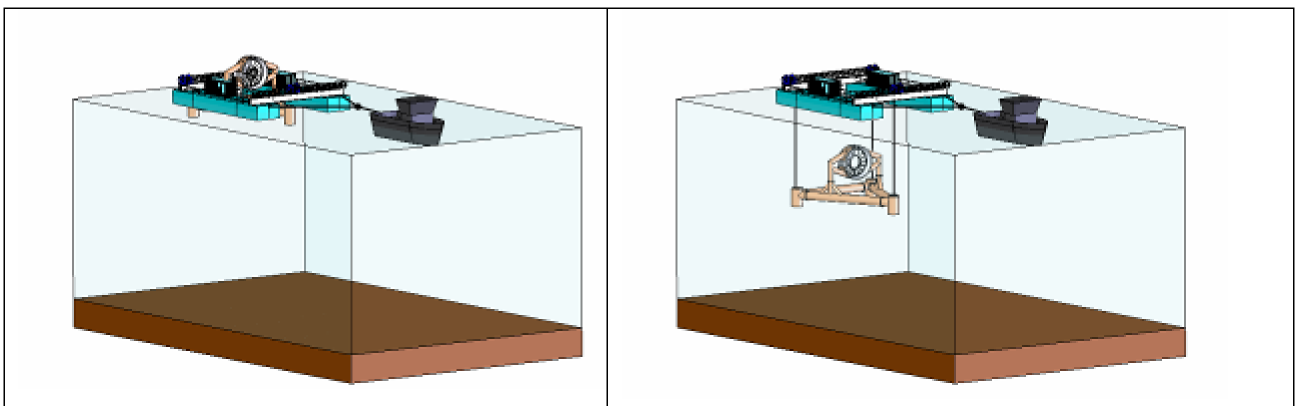
FIGURE 2-6 OPENHYDRO INSTALLATION BARGE

The OpenHydro turbine installation process involves towing a custom designed unmanned installation barge (used in other installations), to which the turbine and subsea base are secured (as illustrated below).

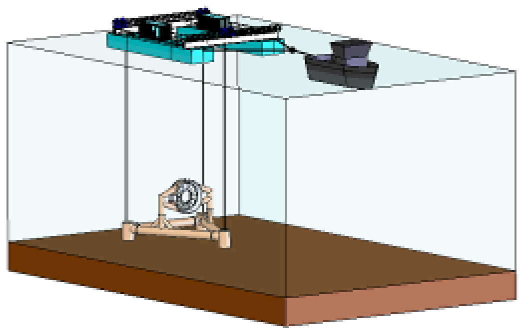
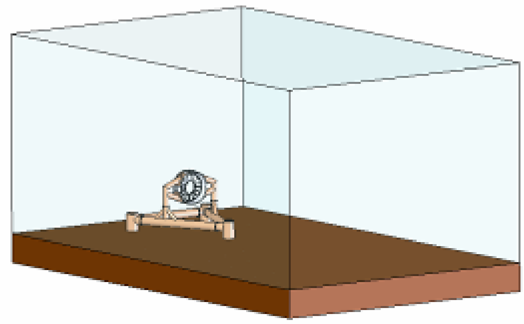
FIGURE 2-7 OPENHYDRO INSTALLATION BARGE WITH TURBINE AND SUBSEA BASE

Once in position at the deployment area, a crew transfers to the barge and use winches to lower the assembly, in a controlled manner, such that the unit's orientation can be adjusted to the optimum position with regard to the prevailing tidal current regime (see next illustration).

FIGURE 2-8 OPENHYDRO SUBSEA DEPLOYMENT METHODOLOGY



1. The Deployment Vehicle is towed to site using a standard tug.	2. Whilst being held in position by the tug, the turbine and GBS are lowered by the Deployment Vehicle.

	
3. Once on the seabed, the lifting lines are released.	4. The turbine will be located on the seabed with no part of the structure visible on the surface.

Seafloor dredging or levelling will not be required at the deployment sites. Under ideal conditions installation is expected to require 1 - 2 days, but it could take longer if adverse weather or sea conditions are experienced. For the MCT unit, installation will take longer if a pile foundation is required (see below).

For the Clean Current unit, as illustrated conceptually in Figure 2-9, the general deployment strategy will be as follows: four tug boats using dynamic positioning (*i.e.,* no sea anchors) will move the combined GBS and turbine to the site; the tug boats will be stationed in a star pattern to hold the structure in position against the tidal currents; the base structure will then be water ballasted and lowered into position; once on the seabed, the lines from the tugboats are detached. The retrieval process will be accomplished in the same manner, with GBS' ballasts being filled with air.

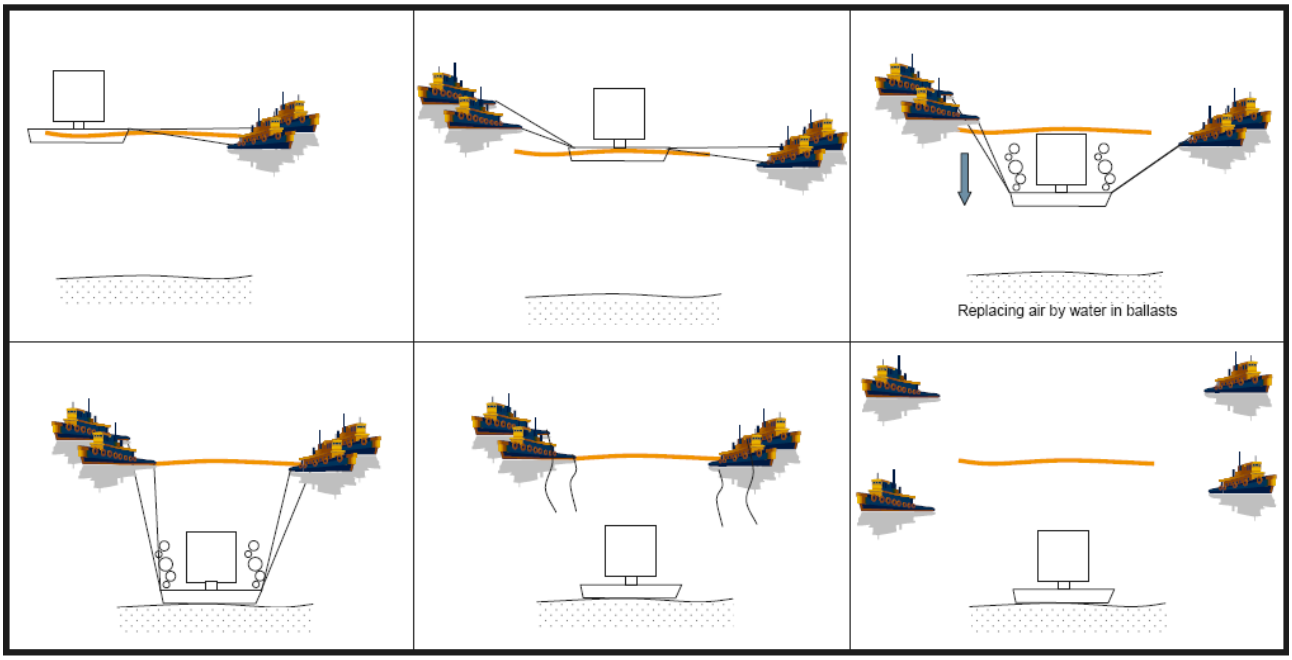
With the exception of OpenHydro, the installation window for this critical phase is the period where tidal velocities are less than 1.0 m/s (approximately 1 hour in Minas Passage, twice per day). All of the following operations are expected to be scheduled during a neap tide week. The expected duration of these activities, including staging activities at the site, is approximately one week per device. All operations are performed around slack tide intervals. Because the turbine is ducted, the exact orientation is not as critical as for unducted turbines. The OpenHydro deployment can be done during a tidal regime, and will not require slack tide.

As indicated the MCT device will likely either be mounted on a steel GBS or a quadrapod steel pin pile foundation set into sockets drilled to suitable bearing strata in the seabed (approximately 10 m below seabed surface). For the MCT GBS deployment option, a similar procedure would be followed as described for the Clean Current turbine above. Detailed design will be undertaken once a final decision is made to use the GBS or the pile foundation approach. The turbine device will be oriented on the seabed so as to optimize the position with regard to the prevailing tidal current regime.

Pile foundation installation, if selected, will follow typical procedures for drilling in the marine environment. This will include use of a drill operating from a barge or specialized ship. The drill will create four sockets in the seabed, one for each of the quadrapod feet. Approximately 71 m^3 of rock cuttings will be generated during drilling. Fine grained drill cuttings (< 3.0 mm) will be returned to the seabed with the drill feed water.

The drilled holes or sockets will be lined with a steel sleeve and once the sleeved socket is completed, the steel pin pile foundation will be towed by tugs and lowered into the prepared holes in the seabed. Finally, concrete grout will be pumped through pipes to secure the pile and the sleeve and fix them permanently into place. The turbine structure will then be towed to the site and lowered onto the foundation. Depending on site conditions, drilling and device installation may take two to four weeks to complete.

FIGURE 2-9 CLEAN CURRENT TURBINE DEPLOYMENT STRATEGY



2.4.1.2 Cable Installation

The preferred approach to cable installation is to install the cable from shore out to the devices, rather than from the sea to land. Installation of the transmission cables will begin at the onshore below-ground cable vault (2 m X 2 m X 4 m) located east of the electrical facility building. Cables will be placed in a trench extending from the onshore vault to an area just beyond the low tide water level.

Two cable installation techniques were considered: direct trenching and horizontal directional drilling. A number of factors including the sensitivity of the terrestrial and beach environment, the geology of the soils and the level of protection required for the cables due to fishing and anchoring in the nearshore were considered when evaluating these techniques.

Horizontal directional drilling was rejected because the shallow marine seismic profiles indicate the sediments in this area (glaciomarine stiff mud overlying muddy sand and gravel) are not competent enough to support this method. In addition, the gravel beach berm consists of unstable unconsolidated cobbles and boulders. Direct trenching was therefore selected as the preferred option.

The working width for cable installation is 50 m in the terrestrial zone and widens to 200 m in the intertidal zone. This includes sufficient work space for equipment movement and equipment and material lay down areas. The working width will be clearly marked and trees, shrubs, debris, and stumps will be removed as necessary to enable cable installation. The centerline of the cable trenchs will be marked.

Installation in the nearshore/intertidal area will begin with site preparation activities. Activities below the high water mark will include installation of a temporary full span “bailey” bridge across a narrow stream, driftwood removal along the cable route, and excavation and installation of six anchors for the cable barge. Above the high water mark, a winch will be set-up near the vault and used to pull the cables in from the barge. Site preparation is anticipated to take approximately two days.

The proposed cable installer (International Telecom Inc. or IT) recommends use of a larger type spud barge (35 m X 18 m or larger) that will accommodate the cable laying machinery as well as the three cable lengths (as illustrated). This type of barge will require three separate “Tractor Tugs” for propulsion. Cable reels will be loaded onto the barge and placed into separate powered cable reel holders. The size and capability of the spud barge will determine whether all three cable reels can be accommodated on the barge at the same time. An alternative to the cable reel holders is to coil the cable into a powered carousel. In either scenario, the cable payout will be controlled by the linear cable engine.

If an appropriately sized and equipped vessel is available, all three cables lengths will be aboard as described above. Otherwise, the cable laying vessel will return to the Port of Saint John to retrieve the second cable length once the first has been laid, and so on. Regardless of the vessel size, the transmission cables will be laid their full length individually.

FIGURE 2-10 EXAMPLE OF A SPUD BARGE

Once the cable(s) have been loaded, the barge will be manoeuvred as close to shore as possible at high tide, allowed to come to rest on its spuds and connected to the anchors installed during site preparation. The tractor tugs will then move to deeper water while shore operations are undertaken. The shore end messenger line will be transferred to the beach and connected to the winch. The winch will pull in the line as the barge simultaneously commences paying out the transmission cable. As each individual transmission cable is winched in to the onshore facility, support structures (stilts) will be used to support the cable and prevent it from dragging across the beach. Cables will be laid gently on the ground next to the area to be trenched.

Once all three cables have been laid, an excavator operating from the beach will excavate the trenches. The common trench will be approximately 4.0 m (at the bottom) wide and 1.0 m deep. Where the cable routes diverge, each individual trench will be excavated approximately 1.0 m wide and 1.0 m deep. Trenching will begin in the dry at low low tide at the low low water mark and will work back toward the shore. The three cables will be lowered into the trenches individually; where they are installed in a common trench, they will be laid side by side with a one-meter separation. Equipment will work in sequence, trenching, laying cable, and backfilling with the excavated material to ensure the cable is laid and the area is stabilized before the tide rises. These activities will not occur in open / flowing water. The disturbed area will be returned to pre-construction condition, to the extent possible.

Cable Installation in the intertidal zone will require crossing one narrow watercourse, shown on Figure 2-5. To minimize the potential adverse effects on fish and fish habitat in the small stream, creek flow will be diverted around the construction area using a dam and pump operation. Dams will be placed upstream and downstream of the excavation and, using appropriately sized pumps, water will be pumped around the site. Pumps will be equipped with fish screens in accordance with the Freshwater Intake End-of-Pipe Fish Screen Guidelines (DFO 1995). Any fish observed in the dammed off zone will be salvaged by a biologist and released downstream prior to trenching. Trenching, cable installation, backfilling and channel stabilization / restoration will occur in a single day. Additional mitigative measures (*i.e.,* sediment and erosion control) will be provided in the Project Environmental Management Plan (EMP).

Under the Activities Designation Regulations, a Water Approval will be obtained prior to undertaking watercourse and wetland alteration activities proposed during the construction phase (*i.e.,* cable crossing of stream and salt marsh).

Beyond the low low water mark, the cables will be simply placed on the seabed. Each cable will be between 2.5 km and 3.0 km in length, depending on the berth location relative to onshore vault. The distance separating the cables on the seafloor may be up to 50 m, to take advantage of the best cable routes (*i.e.,* natural crevices and other terrain features); however, the actual combined cable footprint is relatively small (*i.e.,* 0.15 ha or 0.37 acres), given the diameter of the cables. Cable anchoring to the seafloor will not be required, given its size and weight.

With the exception of OpenHydro which will be deployed in 2009 before the cable is installed, the turbine generators will be deployed with an umbilical cable which will be raised to the surface of a barge and joined with the main transmission cable. Once joined, the cable will then be lowered back to the seabed.

FORCE is considering a 'dry run' of the cable installation, as recommended by the cable installer. This would allow the tug operators to experience the tidal forces and ensure all participants that the right combination of vessels has been selected. It would also allow the barge to hold position on her spuds to ensure sufficient spuds have been deployed to hold position during the cable deployment.

2.4.1.3 Onshore Construction

Construction of the onshore facilities will require the development of the entire 2 ha of leased land, and will include installation of the cables, construction of a building and transformer substation, and installation of the buried power lines to connect to the existing Nova Scotia Power distribution system. Site preparation includes clearing vegetation, grading (as required), excavation and trenching for cable, vault, power line and building foundations. The distance from the transformer substation to the nearest local 25 kV distribution circuit is approximately 100 m. Construction activities include installation and burial of the cables, building and substation construction, connection of the power lines, installation of security fencing and signage, and site paving and landscaping. NSPI will be responsible for the connection from the existing 25 kV power line to the property line of the onshore facility. The connection from the property line to the transformer will be the responsibility of FORCE.

2.4.2 Operations and Maintenance Activities

During the operations phase of the Project, the following general activities are anticipated:

- Monitoring of turbine generator function and performance;
- Environmental effects monitoring; and
- Equipment maintenance, as required.

With the exception of the OpenHydro device (since it will be deployed before the cable is installed), monitoring devices will be powered via a fibre optic cable bundled with the subsea power cable. OpenHydro monitoring equipment will be powered by a battery pack with recharge capability sufficient in power and endurance to last for two years. Data will be stored at the site and collected regularly when the batteries will be recharged (*e.g.,* monthly or quarterly in the summer and winter, respectively). Once the OpenHydro device is connected to the cable, data transfer to shore will occur in real time through the cable.

Once the cables are in place, performance monitoring and measurements capability will be provided to all TISEC operators via the FORCE onshore facility. Monitoring will include, but is not necessarily limited to current monitoring using ADCPs, bearing vibration, generator vibration, turbine speed, generator voltage, generator current, and oil cavity pressure, temperature and humidity. Videos cameras may also be deployed depending on the TISEC device, if required and if technically feasible.

In the case of the Clean Current Turbine, maintenance activities will include temporary removal of the device after approximately two years of operation for inspection. If unscheduled maintenance is required, the device will be transported to a shore facility. To the extent possible, non-operational periods will be minimized.

No scheduled maintenance is expected for the OpenHydro Turbine for the duration of the demonstration. If unplanned maintenance is required the device will be raised to the surface for inspection. If maintenance cannot be done from the barge, the device will be towed to a suitable dockyard.

Similarly for the MCT device, no scheduled maintenance is expected for the duration of the demonstration. If unplanned maintenance is required, the twin units are mounted on either side of a steel monopole and can be raised above the sea level to enable maintenance.

Environmental effects monitoring (EEM) will be outlined in the Environmental Management Plan (EMP) to be developed by the device holders, FORCE and the regulatory agencies. In general, EEM will consist of a variety of approaches which may include video surveys of the devices and nearby seabed, monitoring for noise and vibration, measurements of currents and turbidity, marine mammal and bird observations and lobster tracking. In line with an adaptive management approach and in consultation with the regulatory agencies, acoustic fish/mammal monitoring in the Project area and programs to assess fish/mammal migration through the use of radio tags are also being investigated and will be used where technically applicable and feasible. Monitoring will be conducted using small to medium sized fishing vessels by the various device owners, FORCE, members of academia and scientists from Fisheries and Oceans Canada.

2.4.3 Decommissioning and Abandonment

Upon completion of the demonstration of each of the various technologies, the turbine devices and gravity based structures/pile foundations will be removed from the seabed. Decommissioning activities are anticipated to be similar to the construction activities described for device deployment.

With respect to the subsea cables, FORCE and the device owners/operators will consult with regulatory agencies and stakeholders regarding the need for removal. In some instances, if there is limited interaction between the cables and other infrastructure and activities, it may be decided that the cables are best left in place to prevent unnecessary disruption of benthic communities and fish habitat and reduce the potential for accidental events, albeit minor. Terrestrial facilities will revert to the ownership of the landowner in partial payment for the use of the property.

2.5 Project Schedule

The construction schedule provided in Table 2-3 anticipates a phased approach as outlined below. The schedule assumes that all EA approvals and required permits/authorizations are in place by August 2009.

Table 2-3 Proposed Project Schedule

Date	Activity
Sept./Nov. 2009	Deployment of the NSPI/OpenHydro Turbine
Aug./Sept. 2009	Begin construction of the onshore electrical facility
Mar. 2010	Connection of electrical facility to the NSPI power line
Aug.- Oct. 2010	Installation of subsea cables
Aug.-Sept. 2010/2011	Turbines deployed and connected to cables

Operation of the demonstration turbines will be for a period of at least one year, and potentially extended up to a maximum of four years. Upon completion of the demonstration, the turbines and GBSs will be removed.

Prior to the deployment of the OpenHydro/NSPI turbine in the fall of 2009, it is understood that, in addition to provincial and federal approval of this EA, an *NWPA* Permit will be required as well as a HADD Authorization. Prior to beginning construction of the onshore facilities in the fall of 2009 as proposed above, there are no other regulatory permits or approvals required other than the provincial and federal EA approval. There may however be conditions of the EA approvals that must be met prior to commencing construction.

2.6 Emissions and Discharges

Limited emissions and discharges are expected, given the nature of the project. Throughout construction, operations and maintenance, and decommissioning of the Facility, the proponent, the device owners, and their contractors will adhere to all applicable regulations and standards for both emissions and waste products. Where no standards exist, Project activities will be guided by best industry practices. The Project will employ good engineering practices and standard industry controls to minimize any environmental impact associated with Project emissions. Both the volumes of wastes generated and concentrations of contaminants (if any) entering the environment will be minimized to the extent practical. A Waste Management Plan (WMP) or strategy will be developed and included in the Project-specific Environmental Management Plan (EMP; see Section 2.8). The WMP and will address all phases of Project work. The goal of a WMP is to minimize wastes, discharges and emissions while ensuring the appropriate mitigative measures are used.

2.6.1 Atmospheric Emissions

Sources and types of atmospheric emissions during project construction, operation and decommissioning are typical for most construction projects. Since the actual construction period is short, emissions will be limited in volume. Emissions will include:

- Combustion emissions (*i.e.,* greenhouse gas), noise and vibration, and light emissions from supply, stand-by and work vessels;
- Combustion, noise and vibration, and light emissions from the operation of construction equipment and Project related vehicles (both on and offshore);
- Dust generation (*e.g.,* project related vehicle movement, construction activities); and
- Fugitive emissions (*e.g.,* emission of volatile organic compounds from fuel storage, etc.).

Specific emission types which may be associated with Project activities include: sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide (CO), carbon dioxide (CO_2), trace products of incomplete combustion and particulate matter (PM).

Combustion emissions will be generated from the operation of marine vessels, construction equipment and Project related vehicles. These emissions will be localized and temporary, lasting the duration of individual activities. Emissions will be reduced through proper equipment selection, maintenance and inspection. Consideration will be given to methods to reduce equipment idling, where feasible. Air emissions will not exceed the Nova Scotia Air Quality Regulations (*Environment Act*) and the federal Ambient Air Quality Objectives (*Canadian Environmental Protection Act*).

Noise and vibrations will be generated during construction, monitoring, maintenance and decommissioning activities. Noise and vibration emissions will mainly be generated offshore during the construction and installation of the turbine device (including drilling, if pile foundations are selected for the MCT device) and the subsea cabling (including nearshore trenching). It is anticipated that subsea noise resulting from drilling, if required, will be on the order of approximately 5 Hz. Other noise generating activities offshore will include ship traffic.

In addition to noise generated by vehicles, vessels and equipment, the turbine devices themselves will generate noise. Based on limited studies to date, it is anticipated that noise generated by the turbines may result in behavioural changes in marine wildlife (*e.g.,* avoidance) but will not be of sufficient intensity to cause injury. Part of the goal of this Demonstration Project will be to determine (to the extent possible) the effect of turbine noise on marine life. Additional noise measurements will be made once the units are in operation. In addition, some of the biological monitoring will be focused on detecting the presence and behaviour of fish in the vicinity of the turbines.

Onshore noise and vibration will be limited primarily to the construction of the substation/onshore facility and parking area, and the trenching required to connect the cables to the substation, as well as the connection to NSPI grid. Vehicle emissions will be reduced through proper equipment selection, maintenance and inspection. Additionally, consideration will be given, where feasible, to schedule noise and vibration generating activities to times when they would be the least disruptive to receptors (*e.g.,* residences, migratory birds and marine stocks, etc.).

Dust emissions are related to the operation of vehicles and equipment. Control measures, such as the use of water for dust suppression, will be used in disturbed areas as required to minimize the impacts from fugitive dust. These emissions will be localized and temporary, lasting the duration of construction activities.

Due to the significant tidal fluctuation, it may be necessary to undertake construction, monitoring, maintenance and decommissioning activities at any time of the day or night. Artificial lighting would likely be required for these activities to take place at night safely, and as required for compliance with occupational health and safety standards. All vessels will carry operational, navigation and warning lights. Lighting will comply with relevant offshore standards/ regulations. Emissions will be minimized by shielding lights to shine down only where it is needed, without compromising safety, particularly during the migratory season for most birds, when the risk of drawing birds is greatest.

2.6.2 Liquid Effluents

There is potential for erosion and sedimentation of down gradient of land-based construction activities. In accordance with best industry practices, standard requirements from the Nova Scotia Department of Environment and practices described in the Erosion and Sedimentation Control Handbook for Construction Sites, runoff controls will be used to ensure that effluent generated during Project operations is managed appropriately. Plans for erosion and sediment control will be developed prior to the commencement of construction activities as a part of the Project-specific EMP, and will be implemented to minimize impacts to water quality from construction activities.

During installation, monitoring, maintenance and decommissioning phases, deck drainage of vessels will be discharged overboard. Deck drainage water might contain traces of petroleum hydrocarbons, such as lube oils and diesel fuel. Every effort will be made to prevent chemical contamination on decks of vessels. Storage areas for such materials will have secondary containment to prevent discharge onto deck surfaces. A Spill Response Plan, which will include spills on the decks of vessels, will be developed and included in the Project-specific EMP. Additionally, it is assumed that vessel contractors will have measures in place to minimize the potential for spills associated with their activities.

2.6.3 Solid and Hazardous Wastes

There are a number of potential sources of nonhazardous or solid wastes generated during Project activities, including construction wastes (*e.g.,* wood, scrap metals, insulation waste, packing/crating material, domestic waste). All such wastes generated onshore or on marine vessels will be segregated as recyclable and non-recyclable. Non-recyclable waste will be transported to a licensed landfill. Recyclable material will be collected and transported to a licensed recycling facility. Efforts will be made to minimize the amount of waste generated during the Project by reducing, reusing, recycling and recovering materials to the extent practical. Project procedures for waste management will be described fully in the WMP which will be developed in support of the Project-specific EMP. All procedures will comply with provincial Solid Waste-Resource Management Regulations, municipal and disposal facility requirements.

The Clean Current device does not contain any harmful oils or chemicals. The only chemical used in the device is an environmentally friendly lubricant for the bearing cavity (KEMEL TH100). KEMEL TH100 is a readily bio-degradable gear lubricant based on polyethylene glycol and is generally considered non-toxic. Additionally, the Clean Current device will not utilize a harmful antifouling system, but a fouling-release system, which is silicone based and free of biocides and copper. The non-stick coating will prevent unwanted fouling growth due to its water-repellent physical properties. Reapplication of the fouling-release layer will not be required for a minimum of 5 years.

The OpenHydro unit has no seals or lubricants that could potentially contaminate the environment. Because of the need to store data for a period of at least one year (in advance of cable installation), additional equipment will be required, and its protection will require use of a small amount of biodegradable oil. A similar product will be used in small quantities for the load bank assembly. The product to be used is MIDEL 7131, a biodegradable dielectric insulating fluid. No special protective coating on OpenHydro's GBS is required.

The MCT unit has no seals or lubricants that could potentially contaminate the environment. Where required, vegetable-based lubricants will be used, as well as copper free anti-fouling paint.

All applicable federal and provincial codes and regulations for the handling and transport of hazardous materials will be adhered to, including Workplace Hazardous Materials Information System (WHIMS) and the *Transportation of Dangerous Goods Act* and Regulations. The WMP will be in place to guide all activities related to hazardous waste storage, transport and disposal.

Chemicals and hazardous materials that will be stored on Project related vessels and consumed during the Project may include a variety of industrial cleaners, fuels, oils and lubricants. All hazardous wastes will be brought to shore for recycling, treatment and/ or disposal as required. A Nova Scotia Department of Environment approved hazardous waste contractor will be selected for the disposal of hazardous wastes. Onshore wastes will be handled, treated and disposed of at approved waste handling facilities.

Onshore, hazardous waste that is expected to be generated from Project activities will be minimal (*i.e.,* small quantities of waste oils, cleaning rags, etc.). These materials, if stored on site, will be placed in a dedicated storage barrel designed for this purpose. Hazardous wastes will be removed from the site by a licensed contractor and recycled or disposed of at an approved facility. Additional measures will include the development and implementation of a Spill Management Plan and an Emergency Response and Contingency Plan to avoid impacts from an accidental release of potentially hazardous materials.

2.6.4 Other Emissions

As previously indicated, the deployment of the OpenHydro unit is currently planned for the fall of 2009. Since this deployment is before the cable is installed, electricity generated at the turbine will be dissipated as heat at the device. The energy dissipation system will consist of a load bank assembly mounted on the subsea base. The device holder estimates that the water passing by the unit will see a temperature increase of approximately 0.001 °C.

During the operational phase of the Project, electromagnetic fields (EMFs) from the subsea cable may be produced. EMFs are generated through the acceleration of charged particles. When the velocity of a charged particle fluctuates, an EMF is produced which could potentially interact with aquatic animals that are sensitive to such fields or with humans. The significance of EMF on human health is not will understood and the effects of exposure are unclear. As stated in the Background Report, the scale of specific impacts on the marine environment created by the presence of EMFs is not known, however, research is presently underway to better understand the magnitude of EMF impacts (Jacques Whitford *et al.* 2008). It should be noted that subsea electric cables are common around the world. It should also be noted, that in addition to anthropogenic EMF sources, these fields naturally occur in the marine environment as a result of biochemical, physiological and neurological process within organisms.

There is general agreement amongst industry that "a field of sufficient strength to cause avoidance behaviour in electrosensitive species (typically sharks, skates and rays) will only occur within 10 - 20 cm of the cable; therefore burying the cable and covering with boulder amour is enough protection" (Gill *et. al*. 2007).

Although cables will not buried for the Demonstration Project, they cables will be armoured with two layers of galvanized steel wire. Under these circumstances, and given Project-specific details for the Demonstration Facility, the effect of EMF on electrosensitive species, if present, is expected to be minimal (limited to within a few cm).

2.7 Accidents, Malfunctions and Unplanned Events

All Project equipment will meet the requirements of industry standards and be safety certified and fit for its intended use. Regular inspections and maintenance programs will ensure the continued reliability and integrity of such equipment. Necessary critical spares will be maintained in the event that an equipment change-out is required.

Onshore, refuelling of construction equipment will need to be conducted onsite on a regular basis by a tanker truck. Refuelling of mobile equipment will take place in a designated area, on a low permeability surface. Equipment operators will ensure that they remain with all equipment during refuelling at all times in accordance with the Petroleum Management Regulations. All fuels, chemicals and wastes will be handled in a manner that minimizes or eliminates routine spillage and accidents.

In the event of an on land spill or leak during refuelling, monitoring, maintenance, or general equipment operation, actions will immediately be taken to stop and contain the spilled material. All material that has been contaminated as a result of the spill or leak will be collected and stored in a manner which ensures that it will not be re-released into the environment until it is transported to an approved treatment or disposal facility. In accordance with the provincial Emergency Spill Regulations, all spills will be reported to the 24-hour environmental emergencies reporting hotline. In addition, a spills response and contingency plan will be developed and included in the Project-specific EMP.

All shipping and offshore activities will be conducted in compliance with the *Canada Shipping Act* requirements for vessel inspection and certification, and training and appropriate certificates of competency for operators. Vessels and operators will be required to have procedures in place to safeguard against marine pollution including, but not limited to awareness training of all employees, means of retention of waste oil on board and discharge to shore based reception facilities, and capacity of responding to and clean-up of accidental spills caused by vessels involved in the Project.

Offshore, Project related vessels used during construction, monitoring, maintenance, and decommissioning will have storage areas for the containment of chemicals and petroleum products which may include secondary containment to prevent discharges onto deck surfaces and into the marine environment. All vessels will have spill mitigation and clean-up equipment on board to respond to any deck spills or leaks, including absorbent pads and dry chemicals. These measures will reduce the potential of spilled material entering the water. Spills to the marine environment will be infrequent and are likely to be small in quantity and will disperse rapidly. Spills will be mitigated through the use of non-toxic lubricants (such as vegetable based oils) and the development and application of a Spill Response Plan (including procedures for responding to oiled wildlife), for which all staff will received training. If the event of a spill, procedures will be put in place to respond to and investigate the occurrence and follow up with corrective actions reduce the likelihood of repeat spills.

The location of the Demonstration Facility was selected in consultation with other users of the Minas Passage to minimize the potential for project related collisions with other vessels during construction, operation and decommissioning. However, as a result of the very short time periods when velocities are low in the Minas Basin (*i.e.,* the most favourable window for turbine and cable installation), there is a potential for collisions between vessels or between a vessel and surface piercing structures. The management of marine traffic for the Minas Channel area is under the responsibility of the Canadian Coast Guard's Fundy Marine Communication and Traffic Services Centre (Fundy MCTS) based in Saint John, New Brunswick. It is mandatory that all large vessel traffic in the Bay of Fundy report to the Fundy MCTS at specified points in the Bay. Collisions will be mitigated through the implementation of an exclusion zone around the tidal energy devices, controlling vessel speed, scheduling and coordinating activities with other Passage users, Transport Canada and the Canadian Coast Guard (Fundy MCTS), and posting Notices to Mariners, which would result in permanent markings being established on the appropriate marine navigation charts (Jacques Whitford *et al.* 2008). Any time vessel radio operators are present, they will notify approaching vessels of their presence and the presence of structures. Surface piercing structures will contain navigational aids and anti-collision radar will provide early warning of a potential collision hazard. Contingency and emergency response plans will be developed in support of the Project-specific EMP for responding to collision events.

Most of the Minas Channel is between 25 m and 40 m in depth, ranging to 100 m in the central trough. The speed of the tidal currents at all depths in the narrow part of the Channel reaches 3.1 to 4.1 m/s. Water to the south of the main Channel is carried back and forth by tidal action but seems to remain stationary over a complete tidal cycle. This is an area where seaweed, wreckage and other debris collects and drifts back and forth, from near Cape Split at the inner end to a point south of Isle au Haute at the outer end. Fishermen state that this debris remains in the region until it becomes water-logged and sinks (Bousfield and Leim 1958). The potential for submerged or surface debris to interact with the Project is considered very unlikely as the area in which the debris collects is located to the south of the Project area. The potential for submerged ice to collide with the Project will be addressed in Section 9.3, Effects of the Environment on the Project, Sea Ice.

Other potential accidents, malfunctions and unplanned events considered in Section 7.0 of this document include accidental discovery of archaeological or heritage resources, erosion and sediment control failure and fires.

2.8 Environmental Management

A Project-specific Environmental Management Plan (EMP) will be prepared to describe the procedures required meet regulatory obligations, recommendations in the SEA, and mitigative measures and commitments made in this EA Report. The purpose of the EMP is to:

- Ensure that the commitments to minimize environmental effects in general, and specific regulatory commitments, SEA recommendations, and EA commitments and mitigative measures will be met;
- Provide concise and clear instructions regarding procedures for protecting the environment and minimizing potential environmental effects;
- Document environmental concerns and appropriate protection measures associated with Project activities;
- Provide a reference document for planning and/or conducting specific activities which may have an effect on the environment;
- Function as a training document/guide for environmental education and orientation; and
- Communicate changes in the program through the revision process.

Environmental management is considered an integral element in the way daily activities are undertaken. FORCE and the turbine device owners are committed to upholding this position while complying with applicable laws, regulations and industry standards. An EMP will be developed in order to communicate this commitment as well as detailed Project requirements for environmental management to staff, contractors, regulatory agencies and the public. Those involved in the Project will then incorporate the environmental management practices into their daily work routine. The EMP will be used during construction (and decommissioning) and normal operating conditions at the site. The EMP will also detail the various monitoring programs to be undertaken before (baseline), during (compliance and environmental effects), and after the Project (ongoing environmental effects).

Development of the EMP will be done in consultation with regulatory agencies and will be completed in advance of the commencement of construction.

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6.1. Baseline Monitoring
6.2. Compliance Monitoring
6.3. Environmental Effects Monitoring (EEM)
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7.4. Heritage and Archaeological Discovery
7.5. Erosion Control Failure
8. Incident Reporting
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10. References

Sections 1 and 2 of the EMP will introduce the EMP and provide the overarching objectives, scope and organization of the document (Section 1) as well as the organizational structure for environmental management and the roles and responsibilities of key personnel (Section 2). Section 3 will provide a brief overview of the key environmental and socio-economic issues and concerns specifically associated with the Project.

Sections 4 and 5 of the document will include specific mitigative measures for various activities associated with each phase of the Project to ensure protection of the environment. This will include regulatory requirements, EA commitments and recommendations made in the SEA. Mitigative measures will be provided based on standard construction practices and will be adapted as required to meet the specific needs of the Project and the area. For example, the EMP will include/indicate:

- The appropriate timing of in-water works;
- Fish rescue procedures for work at the terrestrial pond;
- Pre-construction meeting requirements;
- Methodology for isolation of stream flow around worksites;
- Erosion and sediment control and storm water management;
- Requirements for vessel speeds and course;
- Site restoration and stabilization procedures;
- Spill prevention and response procedures; and
- Waste management and refuelling procedures.

Section 6 of the EMP will include the details of the various monitoring programs to be undertaken. These programs will be developed in consultation and co-operation with the FORCE, the device owners and regulatory agencies such as DFO and will include (among other information) descriptions of the equipment to be used, the frequency of the monitoring and reporting requirements.

Baseline monitoring in the Project area has begun and the data collected was used in support of this EA. Additional information will be collected in advance of Project construction to build on initial work and help characterise pre-development conditions. These studies include (but are not necessarily limited to) lobster catachability; marine and terrestrial bird and mammal studies/monitoring; vegetation studies; fish migration; current, conductivity, temperature, salinity, and turbidity monitoring; and acoustic monitoring. This will include establishment of one or more control points from which data will be collected throughout all Project phases and used as a comparison to identify potential changes in the environment that may result from the Project.

Compliance monitoring will be conducted throughout construction, operations and maintenance, and decommissioning phases of the Project. Compliance monitoring is intended to ensure conformity with municipal, provincial, and federal legislation and any conditions of approval to the EA imposed by regulatory agencies. Monitoring/inspection will be conducted by qualified personnel engaged by FORCE who will report to the Project Manager as identified in Section 2. Monitoring frequency will be at regular intervals, and in response to significant storm events to ensure erosion control structure are functioning. Monitoring/inspection personnel will also be on-hand/available to provide guidance and support during construction in sensitive areas and/or during sensitive periods.

As indicated in the SEA and in this EA Report, an environmental effects monitoring (EEM) program will be developed to confirm the impact predictions made with respect to the Project as well as to confirm the appropriateness and effectiveness of the mitigation undertaken. The EEM program will be based on adaptive management principles (*i.e.,* monitor, evaluate and learn, and adapt) and will take advantage of ongoing research to assist in refining monitoring technologies and strategies. In the event that that mitigation is insufficient or ineffective, mitigation measures will be modified and or additional mitigation will be developed and implemented. This approach recognizes the unique and severe environment of the Minas Passage, and as well the uncertainty with respect to the potential for environmental effects associated with the new TISEC technologies.

The EEM program will include but will not necessarily be limited to:

- Fish migration;
- Lobster catchability;
- Electric and Magnetic Fields (EMF);
- Changes to Benthic communities; and,
- Scour and changes to sediment distribution.

In addition to the monitoring described above which will be included in the Project EMP, it is anticipated that each device owner will collect information to monitor the performance and impact of their specific device. This information together with the baseline, compliance and EEM monitoring data will be used to identify design/deployment modifications so as to optimize energy production and minimize environmental effects.

It is understood that there is significant interest and concern among various industry, regulatory and public stakeholder communities regarding the potential for commercial development of tidal energy in the Bay of Fundy. It must be noted that any additional development beyond what is described and assessed in this EA report must proceed through another environmental assessment and approval process. It is anticipated that the data collected in the various monitoring programs described above, and possibly supplemented with additional information, will be used to model potential future development scenarios to ensure developments are appropriately located, planned, and designed and that there is a more certainty regarding the potential environmental effects of the technology.

Section 7 of the EMP will include various contingency and emergency response plans for both land and marine activities. Section 8 will outline the incident reporting requirements and will provide the format and information that must be provided with each report. Incident reporting will include spills reporting and wildlife sitings.

Section 10 of the EMP will include a list of contact within FORCE, the device owners, and the various regulatory agencies that have and/or will be involved through the Project as well as emergency contacts.

3. Description of the Existing Environment

The Bay of Fundy, which forms part of the Gulf of Maine, is a narrow funnel-shaped body of water between Nova Scotia and New Brunswick. Generally, the Bay is divided into the Inner Bay and the Outer Bay areas. The proposed Project is located in the Inner Bay area which is further divided into four regions: the Cobequid Bay; Central Minas Basin; Southern Bight; and Minas Channel. The Bay of Fundy has been under study for more than a century; however, prior to studies associated with this Project, a limited amount of research had been conducted in the Minas Passage region of the Bay of Fundy. Most research was undertaken to evaluate environmental and engineering aspects of the previous round of tidal power development in the 1980s that envisioned the construction of tidal power barrages or dams across regions of the inner Bay of Fundy. Surveys were conducted using low-resolution acoustic systems and details of the seabed morphology, bedrock, sediments, seabed features and bathymetry were lacking (Appendix 3: Fader 2009).

3.1 Physical Environment

3.1.1 Atmospheric Environment and Climate

Weather data were acquired from the Parrsboro, Nova Scotia meteorological station, which meets the World Meteorological Organization's standard to calculate 30-year norms of temperature and precipitation. Additional wind and climatatology information is provided in Appendix 5: Oceans, 2009.

The Demonstration Facility will be in operation throughout the year; therefore, a variety of conditions will occur. Using data from 1971 to 2000, it was found that the average annual temperature in the region is 5.6^{0}C, with an average daily maximum of 10.6^{0}C and an average daily minimum of 1.2^{0}C. The site's close proximity to the coast allows for the ocean to have a moderating effect on the temperature. July and August are the warmest months and the coldest month, January, is marked with the highest snowfall (54.6 cm), however, only 23 cm of snow remains at the months end (Environment Canada 2008).

In the Minas Basin, February and August tend to be the driest months (averaging 90.6 and 93.2 mm of precipitation respectively between 1971 and 2000), while the months from September through January are considered the rainy season (marked by the highest monthly precipitation). Total precipitation in the area averages approximately 1281.6 mm (Environment Canada 2008). Fog is very common in the area, which is usually caused as warm air from the south cools when passing over water. During the winter, fog may exist for approximately two days, however, in the summer, fog can occur for up to 10 days (DFO 2007).

The closest meteorological station where wind speed and direction data is available is the Moncton meteorological station in New Brunswick. The average annual wind speed at the station is approximately 17 km/h (between 1971 and 2000). Through the months of June to August, average winds speeds are slightly lower (13.7 km/h), and through the winter months average winds speeds are slightly higher (19 km/h). The prevailing wind direction is from the southwest (Environment Canada 2008).

To date, air quality monitoring has not been conducted to determine air-quality within the Project area. Air Quality Indexes (AQIs) have been developed based on a number of parameters that are measures at more than 20 sites, which make up the Atlantic Region Ozone Monitoring Network. The closest AQI monitoring station to the Minas Basin is located at Kentville, Nova Scotia.

The AQI indicates air quality based on hourly pollutant measurements of some of all of six common pollutants which include: sulphur dioxide (SO_2), ground-level ozone (O_3), nitrogen dioxide (NO_2), total reduced sulphur

(TRS), carbon monoxide (CO), and fine particulate matter ($PM_{2.5}$). Values for the AQI are divided into four categories presented in Table 3-1.

Table 3-1 Air Quality Index (AQI) Categories (Environment Canada 2007b)

Air Quality Index Value	Category and Interpretation
< 25	Good
26-50	Fair: there may be adverse effects on very sensitive people
51-100	Poor: there may be short-term adverse effects on human or animal populations, or may be significant damage to vegetation and property
> 100	Very Poor: there may be adverse effects on a large proportion of those exposed

During 2008, the Kentville AQI station, which only reports on ground-level ozone, reported “good” or “fair” air quality categories. However, it appears that air quality degrades in the area during the summer, when reports were increasingly in the “fair” category and a small number of reports in the “poor” category (July) (Environment Canada 2007b).

Based on the limited number of emission sources, meteorological conditions, and the rural nature and low population density of the area, it is expected that air quality would be in the “good” category in the Project area and vicinity (Blair pers. comm. 2009).

3.1.2 Physiography

The location of the proposed Demonstration Facility falls within one major physiographic region of eastern Canada known as the Appalachian Region. Within the Appalachian Region there are two divisions: the Atlantic Uplands and the Carboniferous - Triassic Lowlands. The proposed Demonstration Facility site (Minas Passage) falls within the Carboniferous - Triassic Lowlands, named because it is underlain largely by rocks of the Carboniferous and Triassic age. A further subdivision of the Carboniferous – Triassic Lowlands is known as the Fundian Lowlands (Williams *et al.* 1972). During the Triassic age, the Bay of Fundy began to fill with sediments derived from the Appalachian mountain chain. The coarser sediments were folded and uplifted, giving rise to the red sandstone cliffs that are visible in the upper bay, and whose erosion provides much of the suspended sediment in tidal waters at the present day (Amos 1984, Nova Scotia Museum 1996; AGS 2001).

3.1.3 Geography

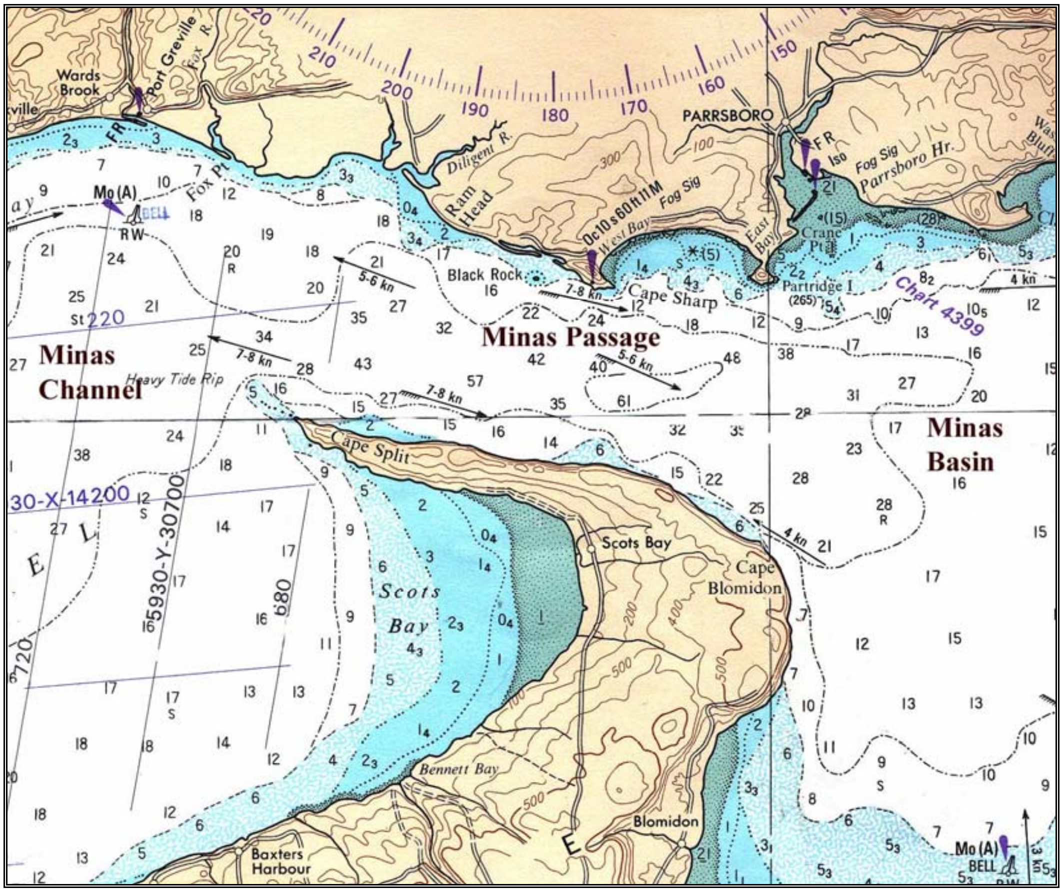
The Bay of the Fundy is a linear embayment, 155 km in length tapering to 48 km wide at its northeastern end where it splits into Chignecto Bay and Minas Channel. The Bay also shallows in a northwest direction from 233 m water depth in the entrance to the Grand Manan Basin down to 45 m at the split.

Minas Passage occurs in the inner part of the Bay of Fundy, connecting the Minas Channel with the Minas Basin.

Minas Passage is approximately 14 km long and is oriented northwest southeast. At its narrowest constriction, it is 5 km wide between Cape Sharp and the southern shore of North Mountain, and at its widest point it is 10 km wide between Parrsboro and Cape Blomidon. Black Rock is a small basalt island that lies in the northern part of Minas Channel to the west of Cape Sharp, approximately 0.5 km offshore (Appendix 3: Fader 2009).

The southern shoreline of Minas Passage is a straight coastline with steep cliffs of North Mountain basalt extending from Cape Split to Blomidon. In contrast, the northern coastline is variable due to the different bedrock types at or near the shoreline. Partridge Island and Cape Sharp are prominent steep sided, high-relief basalt promontories that resist erosion in comparison to the adjacent softer siltstone and shale that have been more heavily eroded. The northern coastline is highly irregular with some straight coastal segments and a large embayment, called West Bay, controlled by the resistant headlands of Cape Sharp and Partridge Island.

FIGURE 3-1 THE CANADIAN HYDROGRAPHIC CHART FOR MINAS PASSAGE, NS (CHART # 4010)



3.1.4 Geology

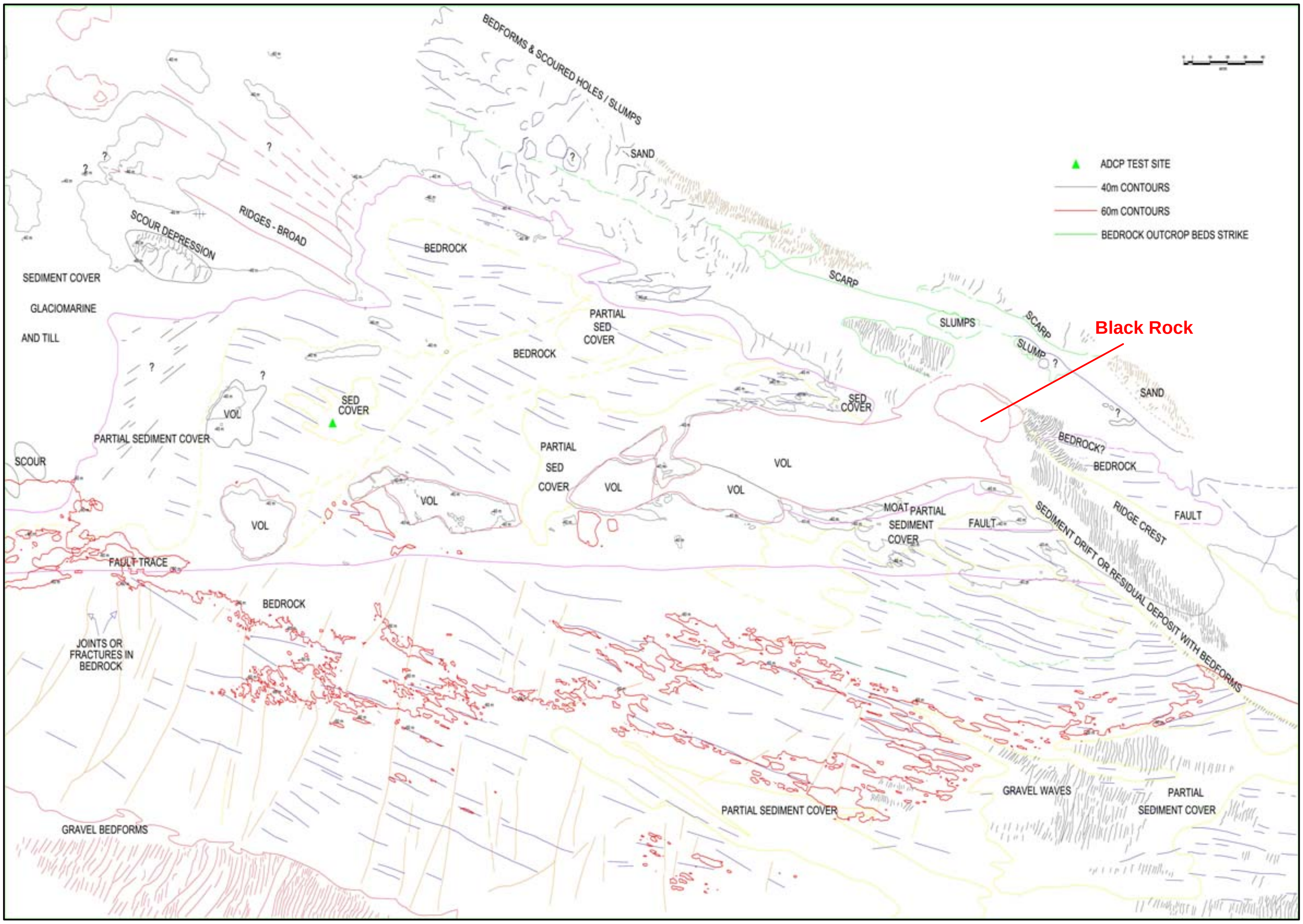
3.1.4.1 Bedrock Geology

In the past, environmental and engineering surveys used low-resolution acoustic systems to map the sea bottom. Results were useful for large areas but details of the seabed morphology, bedrock, sediments, seabed features and bathymetry were lacking. The most recent studies in the Minas Passage were undertaken in 2008 in support of the proposed Project, and included the use of high-resolution seismic reflection systems, sidescan sonar, multibeam bathymetric sonar, cameras and navigation systems. Using this data, a generalized geological map of the seabottom in the Project area is shown below (Appendix 3: Fader 2009).

The main fault zone within the inner Bay of Fundy is part of a major system that occurs along the north flank of the Bay and connects with the Chedabucto-Cobequid system in Nova Scotia. These faults are all part of the Glooscap Fault System (King and MacLean 1976) that continues further to the west and east across the continental shelf.

Within Minas Passage, a large fault is clearly seen on the multibeam bathymetry (below), occurring to the south of the volcanic ridge labelled “vol” that projects to the west from Black Rock. It is manifest on the multibeam bathymetry as a linear depression that varies in width up to 50 m. Wade *et al*. (1996) have mapped a prominent fault on land to the east that may be the same one as identified from the multibeam bathymetry. Several sets of prominent joints occur within the exposed bedrock that trend almost north-south and southwest – northeast. These features occur as linear troughs and may represent suitable locations for placing transmission cables.

FIGURE 3-2 MULTIBEAM BATHYMETRY INTERPRETATION MINAS PASSAGE, NS (2008)



3.1.4.2 Surficial Geology

With the exception of the nearshore regions of Minas Passage, much of the seabed in the project area consists of exposed bedrock. Northwest of the project area, thick surficial sediments overlie the bedrock and have developed large linear furrows, ridges and isolated scour depressions on their surface. An area of gravel hummocks called gravel waves occurs southeast of Black Rock. These gravel waves overlie a thicker deposit of surficial sediments that are thought to represent coarse deposits in the current-sheltered lee of the island.

On the north side of Minas Passage a narrow flat shelf extends from the shoreline, dipping gently seaward to a depth of approximately 10 m. Gravels and sands occur on this shelf and are formed into a variety of bedforms with an orientation perpendicular to the shoreline. The shelf dips steeply from its seaward edge to 40 m water depth, where bedrock begins to crop out on the seabed. This slope is covered in gravel consisting of granules, pebbles, cobbles and boulders. Samples are difficult to collect across this surface because of a dominance of large boulders at the seabed. Seismic reflection profiles across this area show that the thickest material below the slope is largely stratified glaciomarine sediment and till is thin or absent. Overlying the glaciomarine sediment is a more recent deposit of sand and gravel that continues to the shoreline. The western edge of the shelf and adjacent slope down to the seafloor (as well as the region to the north of Black Rock), exhibit features that appear to indicate slumped sediments. Cable routes from the offshore devices have been chosen to avoid these features.

The flat volcanic ridge that extends west from Black Rock is mostly exposed bedrock, but pebbles, cobbles and boulders are common. No fine-grained clays, silts and sands appear to be present. In the region of exposed bedrock ridges to the north and south of the volcanic platform, sediments occur in the flat areas between the exposed ridges. They have a gravel-size cover of granules, pebbles, cobbles and boulders.

3.1.4.3 Crown Lease and Device Location Geology

The proposed Crown Lease Area and three device sites occur to the west of Black Rock and south east of Ram Head, Minas Passage. They all occur in the northern part of Minas Passage: Device Areas B and C occur over stratified outcropping bedrock, and Devise Area A lies over North Mountain basalt. The following is a more detailed description of the bedrock and overlying surficial sediments at each of the proposed device locations, each of which covers an area defined by a 200 m diameter circle (Figure 1-1).

<u>*Site A*</u>

Site A occurs over a volcanic shallow flat platform that extends to the west from the Black Rock region. It is located approximately 1400 m from the centre of Black Rock on the northern part of the volcanic platform. The water depths at Site A average 30 m and boulders larger than 1 m in diameter can be seen on the high resolution multibeam bathymetric imagery. The bedrock surface is rounded and hummocky with a relief of less than 1 m and differs from Sites B and C that display sharp eroded edges of upturned bedrock strata. The slope map of Site A shows that it is a very flat surface and the backscatter imagery indicates that it is an area of very uniform high reflectance (hard). Photographs of the sea bottom are given in Appendix 4 (Envirosphere 2009a).

<u>*Site B*</u>

Site B occurs 2 km west of Black Rock, north of the volcanic platform in a region of largely exposed sedimentary bedrock. Water depths over this region are the deepest of the three locations and average 45 m. The bedrock ridges are upturned strata with rough and undulating surfaces. The strike of the beds (*i.e.,* their linear direction) is northwest, coincidentally close to the direction of the prevailing current. Both the northern and southern regions of Area B have zones of flat seabed. These regions are gravel covered with boulders. The flatness arises from the presence of surficial sediments that fill the deeper regions between bedrock ridges. Based on a regional distribution of sediments throughout Minas Passage, it appears that the subsurface sediments are either till or glaciomarine muds.

Site C

Site C lies 1 km west of Black Rock, just north of the volcanic platform where average water depths are 40 m. Site C consists of exposed bedrock ridges and several flatter regions of gravel with boulders, similar to Site B. Bottom photographs from Area C show both exposed bedrock at the seabed, as well as gravel regions with granules, pebbles, cobbles and boulders. The bedrock is similar to that of Site B and the overlying surficial sediments are interpreted as erosional remnants of both till and glaciomarine sediment. Gravel occurs over the flat regions of the seabed and boulders are common within the gravel and on the bedrock.

Cable Corridor

The selection of the cable corridor is controlled by seabed characteristics and engineering design criteria. One of the criteria for route selection requires that the cable must be able to be removed if required. This results in a route that avoids regions of moving seabed gravel waves that could bury the cable and make recovery difficult. It is important to lay the cable on seabeds that would not abrade the cable and as a result, the crossing of exposed bedrock ridges is not a preferred option. A main route through the sedimentary bedrock region has been chosen in a wide gravel covered flat region of seabed that represents an eroded joint in the bedrock. The individual cable routes to each of the devices have been chosen to run parallel to bedrock strike in the slightly deeper and protected depressions between bedrock ridges that are flat and gravel covered. Steep slopes were avoided and routes were chosen to traverse the terrain with the lowest slopes so that the cable will lie on the seabed rather than be suspended above it.

At the northern end of the sedimentary bedrock region, the cable route crosses the slope and adjacent inner shelf edge in a region with no slumps or scarps and crosses the shelf edge at right angles. The cable route then turns to run southeast on the shallow inner shelf approximately parallel to the shoreline. Areas of rock outcrop are avoided along this part of the route and the cable route takes a final turn to the shoreline in an area north of Black Rock.

3.1.4.4 Terrestrial Geology

The bedrock geology near electrical facility and parking area consists of sedimentary rocks of the Parrsboro Formation of the Cumberland Group. The Parrsboro Formation is approximately 200 m to 1200 m thick and was deposited approximately 300 million years ago. This formation is comprised of sandstone, calcrete limestone, conglomerate, and mudstone (Keppie 2000).

Surficial geology in the area consists of silty till and drumlins (teardrop shaped hummocks) made of slightly siltier till with a higher percentage red clay. The silty till is approximately 3 m to 30 m thick, while drumlins are approximately 4 m to 30 m thick. Generally, soils developed on these deposits have moderate drainage and stoniness and moderate to good buffering capacity for acid rain (Stea *et al*. 1992).

3.1.5 Bathymetry

Basic bathymetry is shown on the Canadian Hydrographic Chart for Minas Passage is Chart # 4010 above. This chart depicts Minas Passage as a narrow body of water constricted to the north of Cape Split as defined by the 20 fathom contour that broadens toward the east, to the north of Cape Blomidon. The deepest depths in the Passage are 61 fathoms in the central area to the south of Cape Sharp.

Chart #4010 also shows a number of current velocity vectors with the highest values being seven to eight knots off Cape Split and Cape Sharp. A current velocity of five to six knots is plotted on the north side off Ram Head. Minas Passage is the region of highest currents in the Bay of Fundy.

At the start of this Project, multibeam bathymetry had just been collected for the Minas Channel and Minas Passage region of the Bay of Fundy by the Geological Survey of Canada and the Canadian Hydrographic Service. That information was obtained and subsequently supplemented with additional multibeam surveys conducted in the Project area by the proponent, to obtain very high-resolution information for Project needs and infrastructure micro-siting.

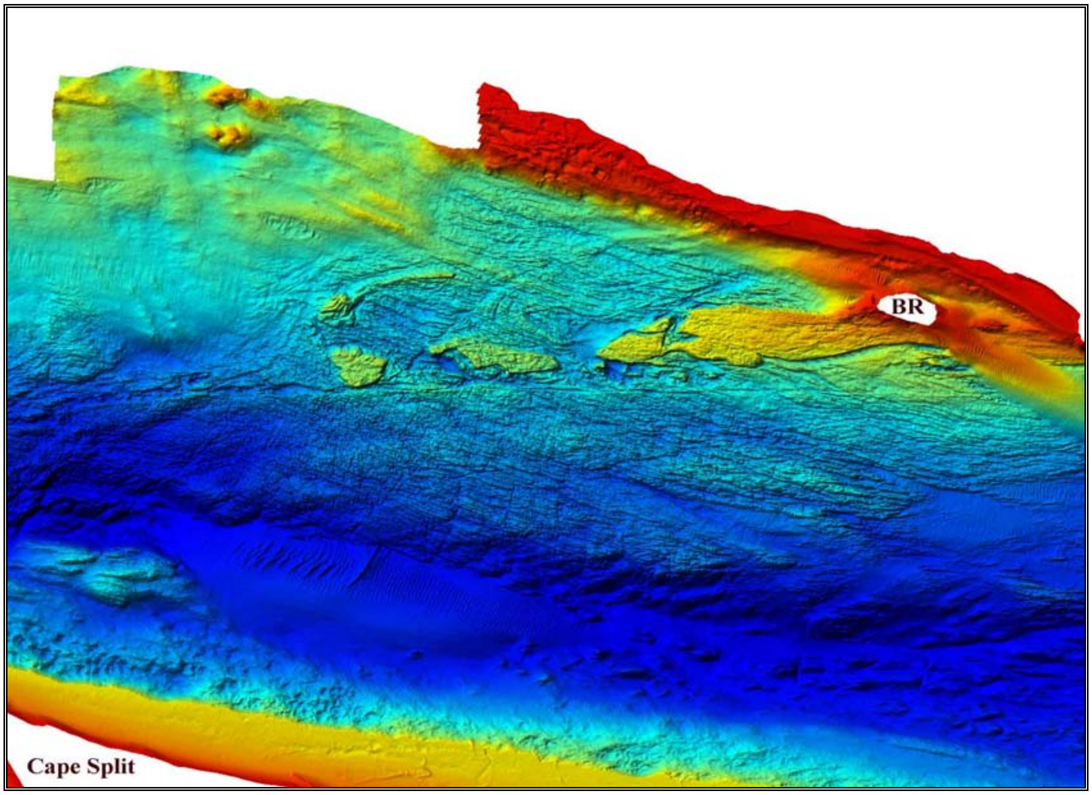
The following is a description of the regional bathymetry of Minas Passage based on multibeam bathymetry.

3.1.5.1 Minas Passage Bathymetry

The regional multibeam bathymetric shaded-relief map below shows the water depths in a colour depth-coded presentation. The map extends from the western tip of Cape Split in the south to Black Rock in the northeast. A major feature of Minas Passage is a deep narrow linear channel that runs throughout Minas Passage oriented parallel to the southern shoreline of North Mountain and has been termed the “Minas Scour Trench”.

FIGURE 3-3 REGIONAL MULTIBEAM BATHYMETRIC SHADED-RELIEF MAP – MINAS PASSAGE, NS

(BR = Black Rock)



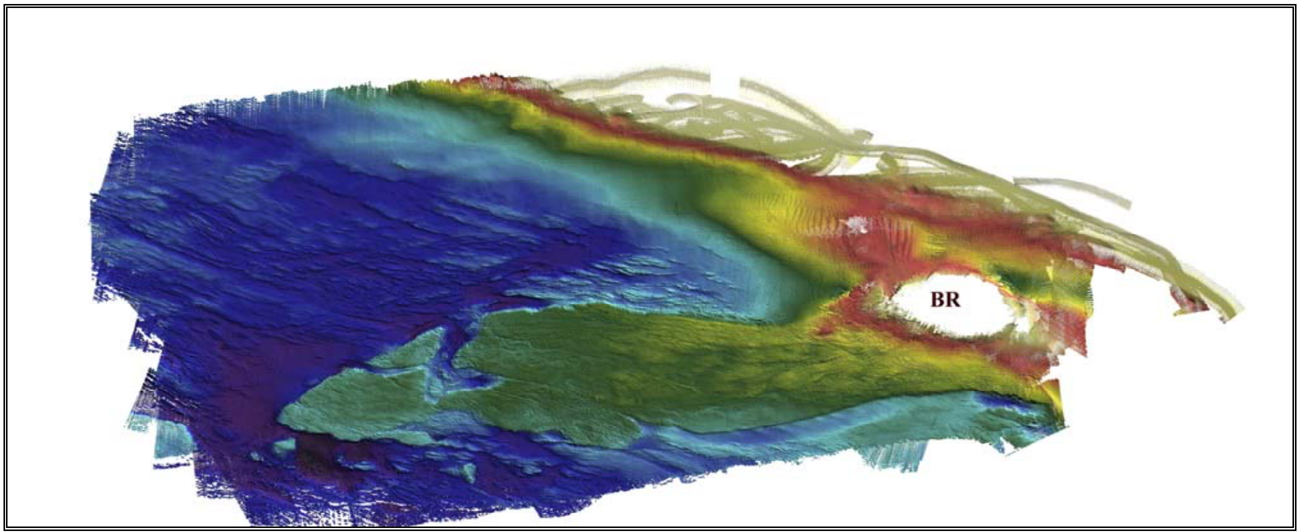
To the north of the deep channel lies a broad bedrock platform 3 km wide with a very rough surface of exposed bedrock ridges and some fields of ripples in gravel. Further north, a prominent series of three flat topped volcanic platforms extends to the west from Black Rock and collectively form a platform that is over 4 km in length. Directly to the south of the volcanic platform is a prominent linear fault that runs east-west parallel to the trend of the platform extending from the southern area of Cape Sharp to the west. The region to the north of the volcanic ridge consists of outcropping sedimentary rock ridges and gravel filled troughs, as previously described. The seabed shallows abruptly toward the north shore of Minas Passage with a shore platform at about 20 m water depth that is approximately 0.5 km wide extending from the low water shoreline.

3.1.5.2 Most Recent Multibeam

An interpretation of the Minas Channel and Minas Passage region was first undertaken using previously published material and reconnaissance seismic reflection, sidescan sonar and sample data collected by the Geological Survey of Canada. This analysis determined that the most appropriate location for a demonstration Tidal power Project was in Minas Passage and that such a location occurred to the west of Black Rock in the northern area of Minas Passage. The siting analysis was based on criteria such as avoidance of seabed hazards, preference for hard and stable seabed, water depth limits for devices, length reductions for marine cables, avoidance of shipping lanes and fishing zones, proximity to the electrical grid and distance from adjacent parkland. Once the area was selected, it was necessary to conduct very high-resolution seabed surveys in order to characterize the seabed in considerable detail and to determine appropriate sites for device micro siting.

The prime system utilized for survey was a Reson multibeam bathymetric sonar system that had an ability to represent the morphologic information at approximately 0.5 m resolution, considerably higher than the previous multibeam data collected by the Geological Survey of Canada that was girded at 2 m. The multibeam information from the high resolution survey was collected over a smaller region that contained potential candidate sites to characterize details of seabed relief and to provide detailed contoured imagery of bottom topography and seabed slope information. The survey covers a region of approximately 4 km by 1.6 km. The following is a general description of the bathymetry based on the detailed multibeam information (see following illustration).

FIGURE 3-4 MOST RECENT MULTIBEAM BATHYMETRIC SHADED RELIEF IMAGE – MINAS PASSAGE, NS



3.2 Marine Environment

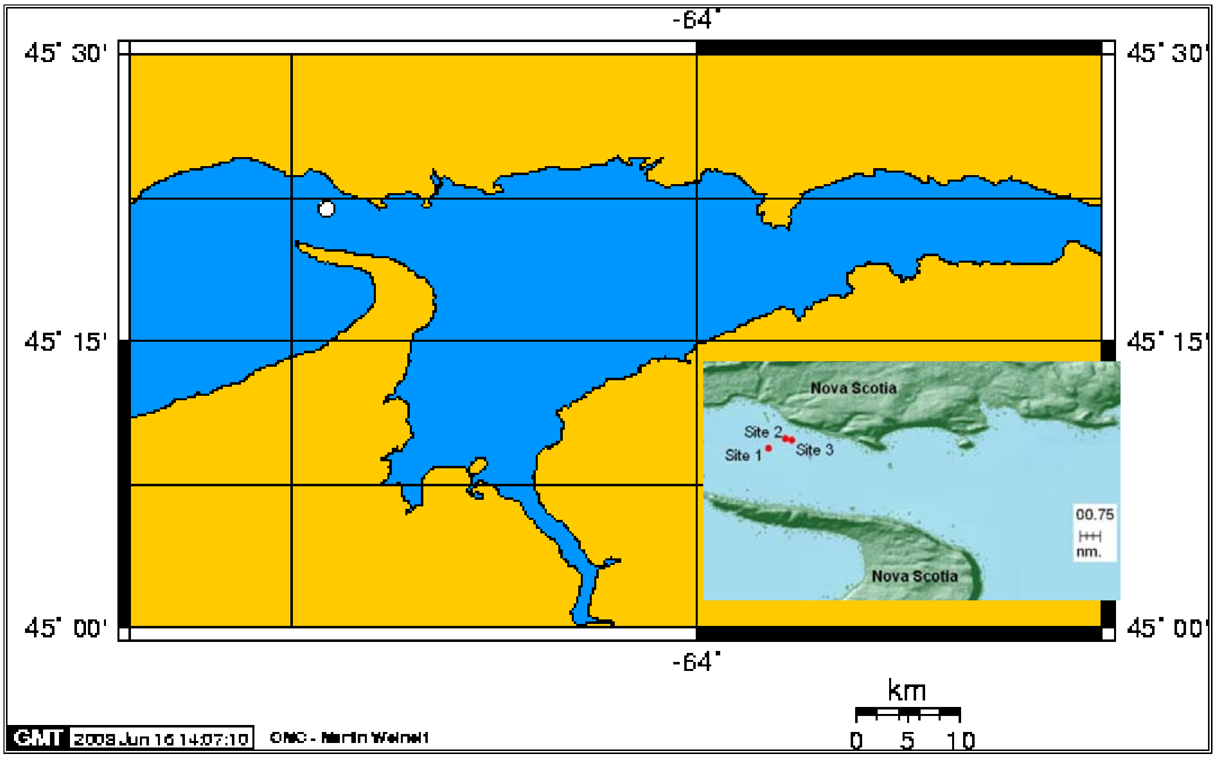
3.2.1 Currents, Tides and Waves

The currents and tides within the proposed Project area were studied between May 1 and September 23, 2008 by Oceans Ltd. (Appendix 5: Oceans Ltd. 2009). The Bay of Fundy with its resonance tides and strong tidal currents makes this area unique for the generation of tidal power. Tides in Minas Basin are greatly amplified and have a range of the order of 10 m. The primary cause of the immense tides is resonance in the Bay of Fundy because its dimensions support the oscillation of a standing wave. The system has a natural oscillation period of approximately 13 hours which is close to the 12.4 hours period of the dominant semi-diurnal (lunar) tide of the Atlantic Ocean.

Currents were measured in Minas Passage during summer of 2008 using Acoustic Doppler Current Profilers (ADCP), in both downward-looking and moored, upward-looking modes, and moored Aanderaa Water Level

Recorders. The following illustration gives the location of the moorings (Sites 1 - 3), and Table 3-2 provides data collected by the instruments in Minas Passage.

FIGURE 3-5 MOORING POSITIONS FOR CURRENT AND TIDE SURVEY – MINAS PASSAGE, NS

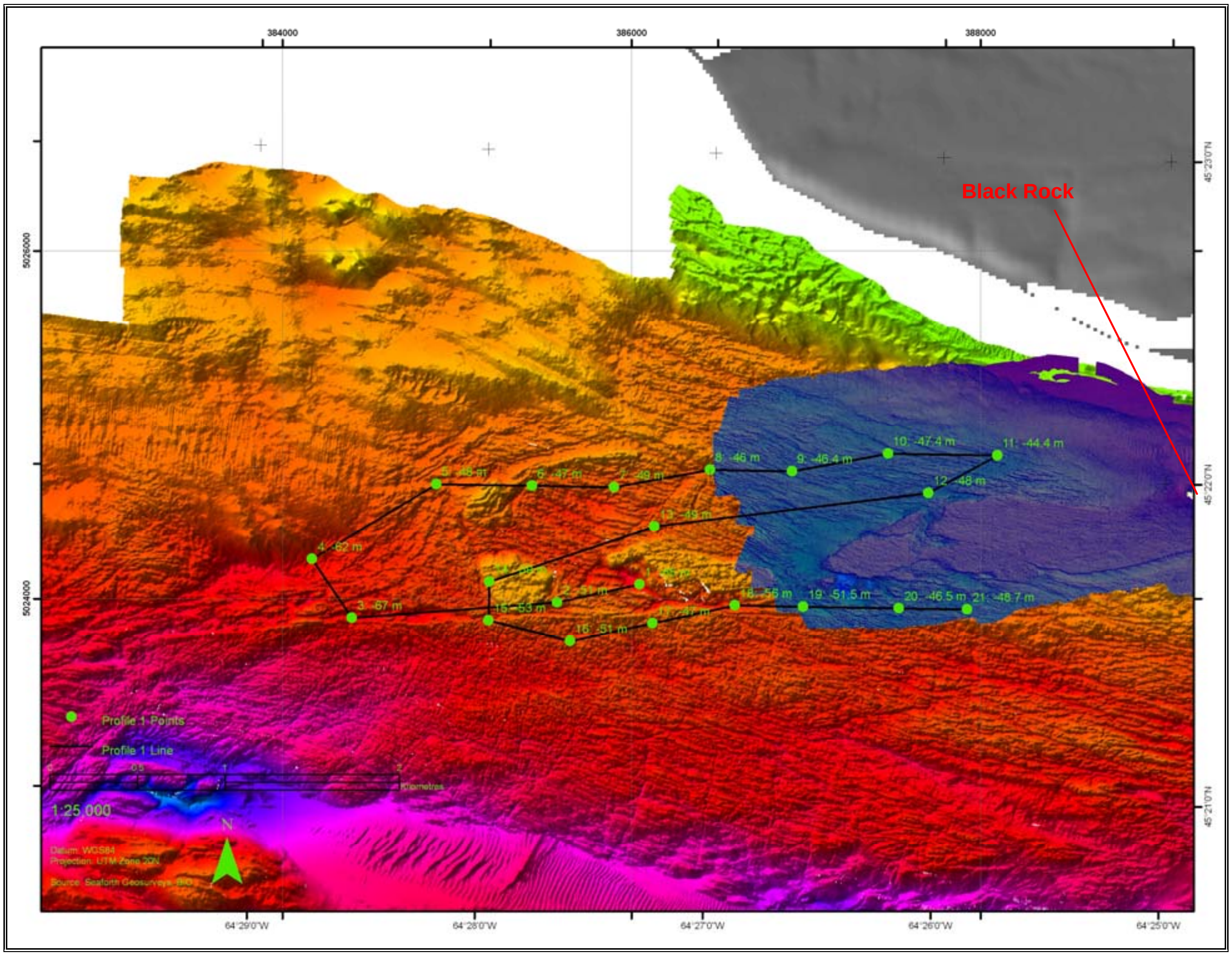


The three moored ADCPs were fixed at the bottom and collected data from the near bottom to the surface. The sampling interval was 10 minutes (ensemble average) and the depth interval was 4 m. The vessel-mounted ADCPs collected data through the water column at different locations with a sampling interval of 10 minutes and a bin size of 4 m on May 1 and 1 m on July 10. A Water Level Recorder was placed on the ADCP bottom stand and measured the water level and bottom water temperature with a sampling interval of 20 minutes. In the Oceans Ltd. report (Appendix 5) water depth refers to the distance from the surface at mid-tide.

Prior to the deployment an ADCP was mounted to the survey vessel on May 1 during falling tide. This unit was used to carry out a series of bottom track profiles in the locations shown in the following illustration (May 1). Precise navigation was provided by Seaforth Engineering. The 3 hours 20 minutes profiling data are of good quality with no data gaps or erroneous values.

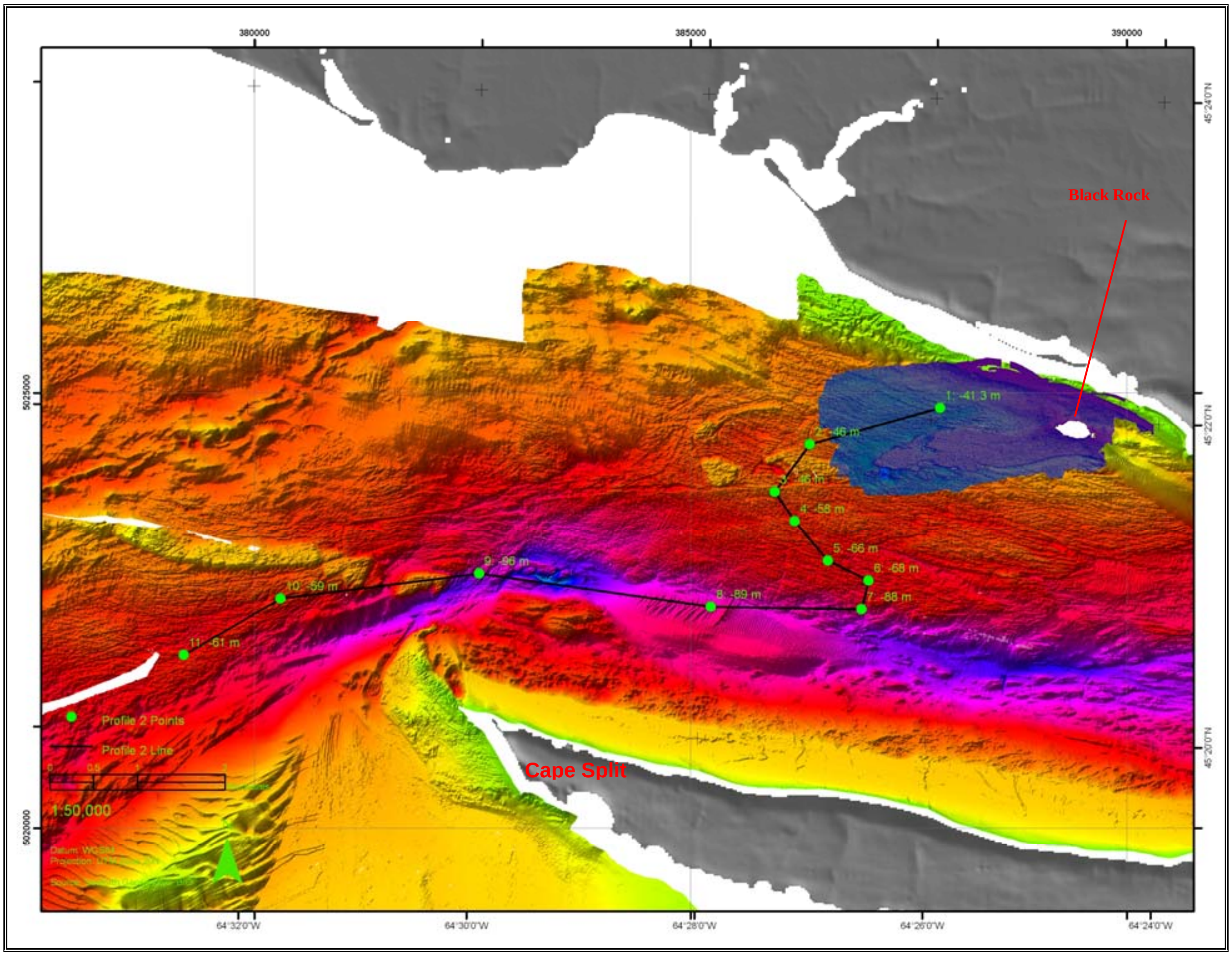
Current directions had no significant change with depth during the sampling time. Current speed had a magnitude of 2.5 m/s at the surface, approximately 2 to 2.5 m/s at mid depths and decreased to 1.5 m/s over the bottom. The current directions were toward the northwest from surface to bottom with an average speed of 2 m/s. The currents were profiled during falling tide and tend to have lower values than rising tide.

FIGURE 3-6 LOCATIONS OF PROFILING AND CURRENT DATA – MAY 1, 2008



Profiling was also carried out at low water on July 10, 2008 at the locations shown in the following illustration (July 10). At mid-depth, the current speed was approximately 1.5 m/s.

Figure 3-7 Locations of Profiling and Current Data – July 10, 2008



Moored ADCPs measure a time series of water currents velocities throughout the water column above a certain depth. Currents in Minas Passage were measured using a bottom mounted RD Instrument 300 kHz ADCP at three sites for a month period at each site.

- Site 1: May 2 – June 4, 2008
- Site 2: June 4 - July 9, 2008
- Site 3: August 20 – September 23, 2008

The mean speed, mean velocity and maximum current speeds with the corresponding directions at specific water depths at each site are presented in Table 3-2. Speed is a scalar quantity with no associated direction. Velocity is a vector quantity with both a magnitude and a direction. The mean velocity is the residual flow over the length of the data record.

The mean velocity or residual flow was towards the southeast (into Minas Basin) at all sites showing that the current had a net flow into the Basin on the northern side. This implies that there would be a net flow out of the Minas Basin on the southern side. The current flowed in only two directions, either into Minas Basin during flood tide or out of Minas Basin during ebb tide. The maximum speeds occurred approximately at the mid-point between high and low waters.

Currents were extremely high, reaching speeds between 4.5 and 5.2 m/s at surface during spring tides. The currents had similar speeds at each Site. The strongest currents were measured at Site 1 located near the center of the Channel. It had speeds of 0.6 m/s more than the speeds of currents at the other two Sites. Current speeds decreased gradually with depth. The difference was approximately 1.3 m/s between surface and bottom at each Site. The currents were still extremely high near the bottom with maximum speeds between 3 and 4 m/s. Currents were mainly aligned in the along-channel direction throughout the water column. The slight difference in current directions between Site 1 and the other two sites was due to the bottom bathymetry.

Table 3-2 Mean and Maximum Current from All Three Sites Surveyed

Site No.	Water Depth (m)	No. of observations	Mean Speed (cm/s)	Mean Velocity (cm/s)	Direction (°T)	Max Speed (cm/s)	Direction (°T)
Site 1	12	4845	249.77	42.4	SE	522.1	108
	20	4845	239.38	41.8	SE	496.8	110
	24	4845	234.79	41.4	SE	483.9	111
	32	4845	221.55	40.2	SE	451.9	111
	36	4845	214.17	39.1	SSE	441.8	111
	48	4845	183.08	35.0	SSE	396.8	112
Site 2	14	5029	203.55	63.73	SEE	458.0	116
	22	5029	194.88	60.53	SEE	523.7	240
	30	5029	183.47	56.00	SEE	423.6	120
	38	5029	168.50	49.17	SEE	385.2	115
	46	5029	142.52	38.03	SEE	324.4	115
Site 3	14	4863	204.27	63.87	SEE	441.3	113
	22	4863	195.89	60.94	SEE	429.8	112
	30	4863	184.52	55.96	SEE	410.0	117
	38	4863	169.09	49.00	SEE	374.2	112
	46	4863	139.17	34.83	SEE	302.4	111

The current in Minas Basin is dominated by the lunar tide with a period of 12.4 hours. On May 7, 2008, low current was at low tide (11:40) and high tide (5:20 and 17:50). The lowest currents always occur at low and high tide over a very short duration. During neap tides, the magnitudes of speeds decreased by 1 m/s as compared with spring tidal currents. The flood (rising tide) and ebb (falling tide) periods in Minas Passage are not equal in duration: flood period was 0.5 hour shorter than ebb at Site 1, and 1 hour shorter at Sites 2 and 3. As a result of tidal asymmetry, the flood currents in Minas Basin are normally stronger than ebb currents: peak flood current is approximately 1 m/s stronger than the peak ebb current. This tidal asymmetry may have effects on sediment transport.

At Sites 1 and 2, there was a slight counter-clockwise shift in current direction from the main axis of Minas Passage, and this shift was more obvious below 36 m depth, indicating it probably resulted from geometric and inertial effects due to bottom topography. At Site 3 there was no asymmetry in current direction since falling tide was in an opposite direction to rising tide along the Channel axis.

The currents in Minas Passage followed a consistent and predictable pattern. The tides were semidiurnal having two high tides and two low tides per day. The current tended to flow in two directions, out of Minas Basin during ebb tide and into the Basin during flood tide. The maximum currents on each tidal cycle were during flood tide. The maximum speed during ebb tide had a value of approximately 1 m/s less than the maximum speed during the previous flood tide. The time interval for the currents to reverse direction was very short, on average approximately 20 minutes. In reference to Appendix 5 (Oceans Ltd. 2009), from the data records, the shortest time interval for currents to reverse direction (from incoming tides to outgoing tides, or from outgoing tides to incoming tides) can be within 10 minutes. For example, at Site 1 ADCP record 448 had the direction of 300, speed of 0.8 cm/s and it was the last records of that outgoing tide, and the next record 449 had the direction of 100, speed of 3.05 cm/s and it was the first record of the following incoming tide. A few other examples of this phenomenon were records 191, 192 at site 4, or 1828, 1829 at site 5, etc. However, there was also evidence showing that currents could change directions within 20 minutes, during 2-record sampling time (e.g. at site 4, records 224, 225, 226, at site 5 records 2083, 2084 and 2085). But the shortest interval is 10 minutes based on the sampling to date. It is possible that the interval of reverse might be even shorter than 10 minutes, but it could not be defined based on the present data due to the sampling interval of ADCP or S4. Additional wave and climatatology information is provided in Appendix 5: Oceans, 2009.

The water level recorders were moored at Sites 1 and 2 to measure surface height during the whole sampling period. The time series plots produced for the Oceans Ltd. report provided in Appendix 5, clearly show the semi-diurnal tidal pattern. The water depth was 58 m at Site 1 and 52 m above the tidal gauge at Site 2, with the water depths measured from the surface at mid-tide. The water level recorder was installed in a bottom stand at a height of 1 m above the sea floor. The water level difference was 12 m between high tide and low tide at both sites.

Time series plots of temperature data near the sea floor were collected at each site by the moored ADCPs and Water Level Recorders. The mean bottom temperature increased gradually from approximately 4°C at the beginning of May to 8°C in June and to 12°C in July. The near bottom temperature reached its maximum of approximately 15 °C in mid-August and remained stable to the end of the sampling period. The bottom temperature displayed a semi-diurnal pattern in the time series data corresponding to the pattern of the semi-diurnal tides. On each day, the water temperature decreased when the colder water of the Bay of Fundy was transported into the basin during flood tide, and then increased during ebb tide.

The sea state or wave potential for the Minas Channel is relatively small, with waves generally in 1 - 2 m range, due to the low windspeeds and the short distances over water to generate waves. However, the largest seas in the Minas Basin can develop over western sections with easterly gales on the flood tide. This can produce 3 - 3.5 m short steep sea. Although strong coastal winds do occur from Economy Point to Cape

Chignecto, particularly in easterlies, this stretch of coastline is well sheltered from northerlies and northwesterlies.

3.2.2 Sediment Transport and Suspended Sediments

Sediments in Minas Passage can be transported in the water column as suspended sediments, carried by melting ice and transported directly along the seabed as bedload. Sources of fine-grained material (silt and clay) include both natural and anthropogenic sources such as rivers, natural erosion of the seabed and shoreline, ocean dumping and seabed bottom fishing activities. Variable and complex tides, currents and morphology in the Bay of Fundy have resulted in a wide diversity of bottom substrates. A report regarding sediment distribution, transport and suspended sediments was prepared by Atlantic Marine Geological Consulting Ltd. (2009) and is included in Appendix 3 (Fader 2009).

Seabed of the Minas Passage

The multibeam (MB) backscatter data indicate surficial sediments at the seabed of the Crown Lease area are all gravel – that is, granules, pebbles, cobbles and boulders; no mud or sand is present at the seabed. The sidescan sonograms also show high reflectivity indicating that the seabed is very hard (gravel). The high-resolution multibeam bathymetry shows large boulders (up to 5 m in diameter), often in clusters, on the gravel and exposed bedrock surfaces. Large areas of the seabed consist of bare bedrock in the form of exposed jagged ridges or flat volcanic areas.

Attempts at sampling the gravels were only partially successful, returning a few gravel clasts in most cases. Bottom photographs and video of the seabed provide critical evidence in understanding sediment transport, sediment deposition and erosion. Over 600 bottom photographs and hours of video have been analyzed for particle size, shape, sorting, distribution, stability and biological growth. This information has been integrated with the results from the interpretation of the sidescan sonograms and high resolution multibeam bathymetry.

No sand sized sediments or silts and clays were observed on the seabed of the Crown Lease area. Most of the photographs were taken during times of slack water and so suspended particles would be expected to settle temporarily on the seabed. This was not observed on the photographic data suggesting that in the study area, little sand is in suspension and that silt and clay are either in low concentration in the water column or do not settle to the seabed. Additionally, as depicted in the bottom photographs, pebbles, cobbles and small boulders have no attached biological growth. Larger boulders and adjacent bedrock have broad coverings of low growth that start at about 20 cm above the seabed. This suggests that the smaller gravel sizes that have clean surfaces may be moving and rolling around as bedload that prevents growth in the zone immediate to the seabed. The movement is likely local and confined by the bedrock ridges and large boulders of the region. No boulders in the photographs show tilted sediment lines that would indicate recent movement and repositioning. The seabed therefore, appears as a mature hard scoured bottom of bedrock and gravel.

Sediment Bedforms

Within Minas Passage there are five areas of bedforms in sand and gravel. Repetitive multibeam bathymetric surveys over ten years show that these bedforms have slightly changed their distribution and orientation with time. There are a few gravel bedforms in the northeast corner of the Crown Lease area but none within the actual proposed device berths. Granules, pebbles and cobbles may move locally but are not thick and abundant enough to form bedforms, or the currents are not strong enough.

Sub Surface Sediment

The seismic reflection data from adjacent areas, as well as from the slope area to the north of the Crown Lease Site clearly shows that stratified sediments interpreted as glaciomarine muds (rather than till) are the dominant glacial sediment in the region. Till normally contains over 50% gravel and in strong currents is only slightly eroded and armoured by the cover of gravel. With the development of this armoured layer further erosion is suppressed. The fact that Minas Passage is a large deep scoured depression suggests that till was not the dominant material that originally filled this depression, as it is not easily eroded in strong currents. Glaciomarine sediments are regionally thick suggesting that glaciomarine mud may occur beneath the gravel lag with boulders. The thickness of this mud over bedrock could be greater closer to shore than further offshore. In addition, the wider the flat area between exposed bedrock ridges, the greater likelihood that the glaciomarine mud is of greater thickness.

Suspended Sediment

Data gathered by the Geological Survey of Canada in 1998 clearly shows that the dominant sediment overlying bedrock in the inner Bay of Fundy is glaciomarine Emerald Silt that consists of silt, clay, sand and some gravel, and was deposited by floating glaciers and glacial plumes from sub ice water, but not directly by ice contact with the seabed as is till.

Based on interpretation of the new multibeam bathymetry (2006 – 2008) collected by the Canadian Hydrographic Service and the Geological Survey of Canada (Atlantic), fine-grained sediment in suspension in Minas Passage originates from the inner part of the Bay of Fundy, from adjacent Minas Channel in the west, from the entrance to Minas Basin in the east and from near shore slope areas of the northern part of Minas Channel where slumped deposits occur. The multibeam bathymetry from Minas Channel and the entrance to Minas Passage shows that scouring of the seabed in glaciomarine sediments is a continuing process over very large areas and that the seabed has not been scoured down to the bedrock as has Minas Passage

Samples from sediment traps placed on ADCPs in 2008 contained fine-grained muds, minor sand and granules and a few pebbles. It is not clear if the material in the traps was collected by settling during slack water or inadvertently during difficult recovery efforts through system dragging. The dominance of marine growth on bedrock and boulders above a 20 cm exclusion zone suggests that the bedload zone is confined to the immediate seabed so that granules, pebbles and cobbles would not likely be transported above that level.

The potential for seabed scour associated with the turbines' gravity based structures depends on the design that includes the area and shape of the platform feet and whether they are located on bedrock or gravelly seabeds. The thickness of the gravel at the seabed and the presence if any of subsurface till or glaciomarine muddy sediments is an important component of such an assessment. Based on a regional assessment of sediments between bedrock ridges, it is interpreted that the subsurface material would be patchy in distribution beneath the gravel lag. The gravel lags are continuous with many large boulders and scouring was not observed around any of the boulders.

3.2.3 Ice

Ice coverage of the Bay of Fundy has been mapped by the Canadian Ice Service (CIS) for a number of years. This is not carried out routinely since it is not considered a significant shipping area. Unlike with the Gulf of St Lawrence and the coast of Newfoundland and Labrador, no routine over flights are undertaken.

Mapping is primarily achieved from the analysis of satellite images and these are analyzed to give an idea of thickness, age and actual cover.

Sidescan sonar surveys are useful for wide area assessments to detect the presence and effects of grounded moving submerged ice. It is one component of a multi faceted approach to addressing the potential problem of submerged moving ice. High resolution sidescan sonar systems can detect features at the seabed as small as 10 cm and are particularly adept at characterizing linear seabed features including cables, ice scour features and anchor marks. Large ice blocks in the inner Bay of Fundy have been documented to move across the mudflats in response to currents and wind, making distinctive linear troughs with flanking berms. It is not known if these scours continue into the deeper water areas where the ice that formed them may represent a hazard to bottom mounted structures.

As discussed in the SEA Background Report, ice in the Upper Bay of Fundy frequently forms over large areas at times of low tide and when the intertidal zone is exposed. When the tide floods, shore ice may then be refloated, broken or piled up to form multi-layered ice blocks. These blocks may be several meters in height and often become grounded in the intertidal zone when the tide falls, causing the surficial sediments to scour. When temperatures are extremely cold, the surface of the sea may freeze forming large floes that move with the tides (Jacques Whitford *et al.* 2008).

The sides of the bay and the channel are protected from further narrowing during the winter as a result of armouring by ice (Desplanque and Mossman 2004). An additional implication of ice presented in the SEA Background report is the stripping of surface sediment and potentially above ground vegetation (in areas of salt marsh) as ice freezes in the intertidal zone at low tide and is then refloated by the flood (Daborn and Dadswell 1988; Partridge 2000; Daborn *et al.* 2003). This material is then released as ice melts, or due to the high sediment load that can become trapped, ice may lose buoyancy and float below the surface (Jacques Whitford *et al.*2008).

There are two separate potential hazards which can arise from ice in this area and one of the tasks facing the device developers is to understand and qualify the degree of risk. The first issue is that of ice cover. Any marine operations, installation, service or removal, which must take place during the ice season will face the potential of being carried out in the presence of sea ice and permanent installations may accumulate ice in the winter. The second issue is that of neutrally or negatively buoyant ice floes, formed on the intertidal zone with embedded sand, gravel and rocks that may drift with the tidal current and pose a physical risk to the actual turbines.

Multiyear studies are currently being undertaken by Oceans Ltd. in support of this Project. Since one components of the program is to address the overall question of the existence of neutrally to negatively buoyant ice that may move in the water column or across the seabed, an ice/sediment sampling program is being undertaken. As a second component of the study, Oceans Ltd. in cooperation with MBP&P has designed and implemented a program to track the pieces of ice which, having grown on the shores and beaches, are loaded with sand and gravel. The initial work was conducted in the spring of 2009 and the preliminary results (Smith *et al.* 2009) were recently reported at the 8th Bay of Fundy Science Workshop in May, 2009. This study included the collection of 93 sediment laden ice samples from 34 locations around the Minas Basin during the period of March, 2009 to early April, 2009, in an attempt to estimate the occurrence and probability of negatively or neutrally buoyant ice. Ten GPS tracking systems were fixed on separate ice cakes to determine the movement of ice and further study their dynamic behavior.

Ice characteristics from the samples will provide insight into the nature of sediment-laden ice in the Bay of Fundy. The result of a trend analysis, which compared ice density against latitude, longitude, and temperature indicate that the ice density distribution can be considered random from area to area, with some localized averaging for samples extracted from a single location. While it was observed during testing that all samples physically floated, the data analysis determined that a small percentage (four samples) could be considered negatively buoyant. The uncertainty associated with the measurements caused two samples to be at risk of being neutrally buoyant. Ongoing studies will continue to verify and expand upon the results obtained from this and other associated studies.

If negatively buoyant ice is common is not known if the seabed impacts are intermittent or continuous. Sidescan sonar data would provide such evidence. It would compliment measurements made through the use of ADCP technology, but would provide results that are regionally significant. It offers the promise to determine if ice has impacted the seabed over a very large region and the surveys can be conducted over a short time frame. Such an assessment will provide an understanding of the potential risk associated with moving submerged ice on bottom mounted structures. Given that the proposed studies are multi-disciplinary and multi-year in concept, an integrated approach to data management is fundamental. All data collected will be integrated into a GIS developed by Seaforth Engineering.

3.2.4 Marine Water Quality

Extensive vertical mixing, a result of large tidal fluctuations in combination with small freshwater inputs, produces fairly homogenous water temperatures within the Minas Basin, where the vertical temperature profile generally does not vary by more than 1.5^0C from the bottom to the top of the water column (Daborn and Pennachetti 1979). Surface water becomes warmer during periods of rising tides by absorbing the heat of the mud flats which were previously exposed to sunlight. In general, due to the relatively large surface area of the intertidal mudflats, waters tend to be warmer during the summer months and colder during the winter months in the Minas Basin than in other areas of the Bay of Fundy (Craig 1976). Water temperatures in the Minas Basin may range from -1.5^0C during the winter months when ice is common, to over 15^0C during the summer months (DFO 2007).

Freshwater inputs from a number of rivers (*i.e.,* Salmon, Avon, Shubenacadie Rivers) into the Minas Basin result in water salinities which are only slightly lower than in the open ocean. The salinity ranges from about 31 ppt in the Minas Channel to 28 ppt in the upper regions of Cobequid Bay to the east (DFO 2007). It has been observed that during winter months when there are less freshwater inputs, the salinity of the Minas Basin tends to be slightly higher and more uniform than at other times of the year (Greenberg 1984; Appendix 6: Envirosphere 2009b).

The tidal force in the Project area is predominant, and because of resonance, establishes a macro-tidal environment. The vigorous vertical mixing, which results from extreme tidal fluctuations, sufficiently maintains well oxygenated waters in the Minas Basin (DFO 2007). Additionally, tidal processes determine the concentrations of nutrient and sediments in the water column. Nutrient levels are the result of interactions between the water column, the intertidal salt marshes and the underlying sediments (Jacques Whitford *et al.* 2008). Generally, the Minas Basin has moderate to high levels of suspended particulate matter which becomes re-suspended as tides move over the intertidal salt marsh, mudflat areas. The basin is relatively unaltered by anthropogenic contaminants often carried by rivers from urban or industrial areas, or from rivers which drain agricultural lands, and yet the levels of certain dissolved metals are elevated in marine waters of the basin (DFO 2007).

A 2002 study by Westhead (Fisheries and Oceans/Acadia University), in conjunction with a research cruise undertaken by the Department of Fisheries and Ocean Canada, evaluated metal concentrations in the water and surficial sediments of the Minas Basin. Results indicated that the overall contaminant levels in the water and sediment of the basin are low to moderate. Along the north shore of the Minas Basin, results indicated elevated copper levels in the intertidal sediments, typical of the area which is known to have natural enrichments of copper from river sediments. Several dissolved metal concentrations were found to be above threshold effects, but below probable effects levels within the Minas Basin (Yeats and Westhead 2007). Terrestrial contaminant sources, via river inputs and the re-suspension of bottom materials, account for the main sources for particulate metals in the water column of the Minas Basin (DFO 2007).

The Gulfwatch Mussel Monitoring Program, initiated in 1991, is a program designed to monitor chemical contamination using the blue mussel (*Mytilus edulis*) as an indicator species. The program includes the monitoring of nine sites located within the Bay of Fundy. Results from 1997 revealed low levels of silver, lead, zinc, cadmium, copper and organic contaminants (organochlorine pesticides and DDT), as well as slightly elevated concentrations of chromium, nickel and mercury within the tissues of mussels (DFO 2007).

3.2.5 Marine Benthos

Marine benthos refers to those organisms which are associated with bottom substrates. They may be semi or permanently attached to hard (rocky) substrates, buried in soft sediments, or move around on the surface of the seafloor. The distribution of marine benthos is determined primarily by the nature of available substrates; however, other factors such as exposure to the atmosphere, exposure to predation, and salinity also play a role in determining their distribution. Another factor which is thought to influence species dominance in subtidal areas is the strength of tidal currents which influences sediment stability, larval settlement and/or feeding ability (Wildish and Peer 1983). Suspension feeders are dominant in areas of high currents where organic matter does not settle out, while deposit feeders are dominant in areas with low current speeds where deposition of organic matter allows these feeders to gather food at the bottom.

The study area is part of the Inner Bay of Fundy, and includes the Minas Passage/Minas Channel in which the study site is located, and the Minas Basin, the shallow inland basin to the east. Unusual tidal conditions in Minas Passage promote mixing through the water column, with near uniform temperatures and salinities observed from surface to bottom (Bousfield and Leim 1958) and water temperatures which are warmer in winter and colder in summer than adjacent areas. Salinities are less estuarine than in Minas Basin due to the influence of waters from the outer Bay of Fundy.

The invertebrate fauna and seaweeds of the study area have been well studied, chiefly through studies along the shoreline (*e.g.,* Bousfield and Leim 1958) and in Minas Basin, although information on the fauna on the seabed at the study area is not known specifically, due to the difficulty of obtaining bottom samples on the rocky bottom there. A study of benthic communities on either side of Minas Channel (Wildish *et al*. 1983) sampled benthic communities on softer bottom, and a recent NRCan multibeam bathymetry survey (Cruise 2007-023), recovered several seabed rocks with surface organisms (*Flustra* and coralline algae) at the study area. Benthic communities in the Project area are expected to include representatives of the northwest Atlantic boreal invertebrate fauna, based on cooler water temperatures occurring at the site. A notable feature of benthic communities in the adjacent Minas Basin is the high proportion of endemic, warm water species which normally occur further south along the eastern North American coast and in warm water enclaves to the north.

High suspended sediment levels in Minas Basin are important factors in the biology of organisms, but are not an issue at the Project site, where suspended sediment levels are typically lower. The occurrence of several species of 'boring clams' (clams which abrade burrows in outcrops of soft rock in intertidal areas), is also noteworthy in the Minas Basin. The clams include the false angel wing, *Petricola pholadiformis,* Great Piddock (*Zirfaea crispata),* and the angel wing (*Barnea truncata),* all of which occur uncommonly in Minas Basin, one of which (*Zirfaea)* is rare. The rock formations in which these species occur in the intertidal zone (soft siltstone/mudstone outcrops) are similar to outcrops in the sedimentary bedrock areas of the study area, although the latter occur at much greater depths. Based on its location, the fauna of the study area likely contains a mix of species which occur on similar substrates both in Minas Basin and in the outer Bay of Fundy.

Information on benthic animal and seaweed communities was obtained from seabed video and still camera photography in August and September 2008, as well as from several bottom samples obtained by scallop dredge in August 2008. Underwater video was obtained from the intertidal zone extending offshore roughly along the proposed cable route, and broadly over the subtidal zone of the study area. Depths below mean low water were obtained from the detailed bathymetric site survey for the Project. An intertidal survey, consisting of transects extending parallel to the proposed cable corridor conducted in October 2008, provided additional information on benthic and seaweed communities in the lower intertidal and upper subtidal zone.

Seaweeds

Occurrence of seaweeds at the Project site along the cable corridor and in the vicinity of the shore facilities is limited to scattered occurrences of rockweed (*Fucus* sp. and *Ascophyllum nodosum)* and sea lettuce (*Ulva lactuca)* in clumps in the lower intertidal, and in tide pools which form above gravel bars in the mid-intertidal. *Fucus, Chondrus crispus*, and coralline algae (*Lithothamnium* sp) occur on gravel and cobble in the upper 2 m to 3 m of the subtidal zone. Seaweed distribution in these areas is limited by the low availability of stable rock substrate, as the beach materials are primarily gravels and cobbles which would be moved by currents and wave action. Bedrock such as the outcrop which forms Black Rock, likely support dense, more diverse seaweed communities in the subtidal zone; and although dulse harvesting is reported anecdotally, these communities were not surveyed in the baseline study. Some drift seaweeds including kelps occur in the intertidal zone presumably originating on near surface bedrock formations.

Macrofauna

Several types of benthic communities occur at the site, dependent on bottom substrate type and depth below mean low water (MLW) (Table 3-3). The distribution of the main communities is shown in the following illustration. The subtidal zone at the site is roughly divided into a shallow longshore shelf extending approxiamtely 350 m from the high tide mark to depths of 7 m to 10 m, followed by a sharp drop-off to a depth of 25 m below MLW into a gradually sloping area of unconsolidated boulder and cobble bottom. Further seaward, the bottom consists of a zone of sediment, bedrock outcrops, and a shallow plateau of volcanic bedrock. Most of the benthic communities at the study site are thus characteristic of deep water environments. Four main types of communities were observed: 1) shallow unconsolidated gravel; 2) deep unconsolidated cobble to boulder; 3) deep sedimentary bedrock outcrops; and 4) deep volcanic bedrock platforms. Additional video surveying of benthic habitat will be conducted in June 2009, as required, to ensure that changes to the cable route are captured.

FIGURE 3-8 BENTHIC COMMUNITIES IN THE STUDY AREA – MINAS PASSAGE, NS

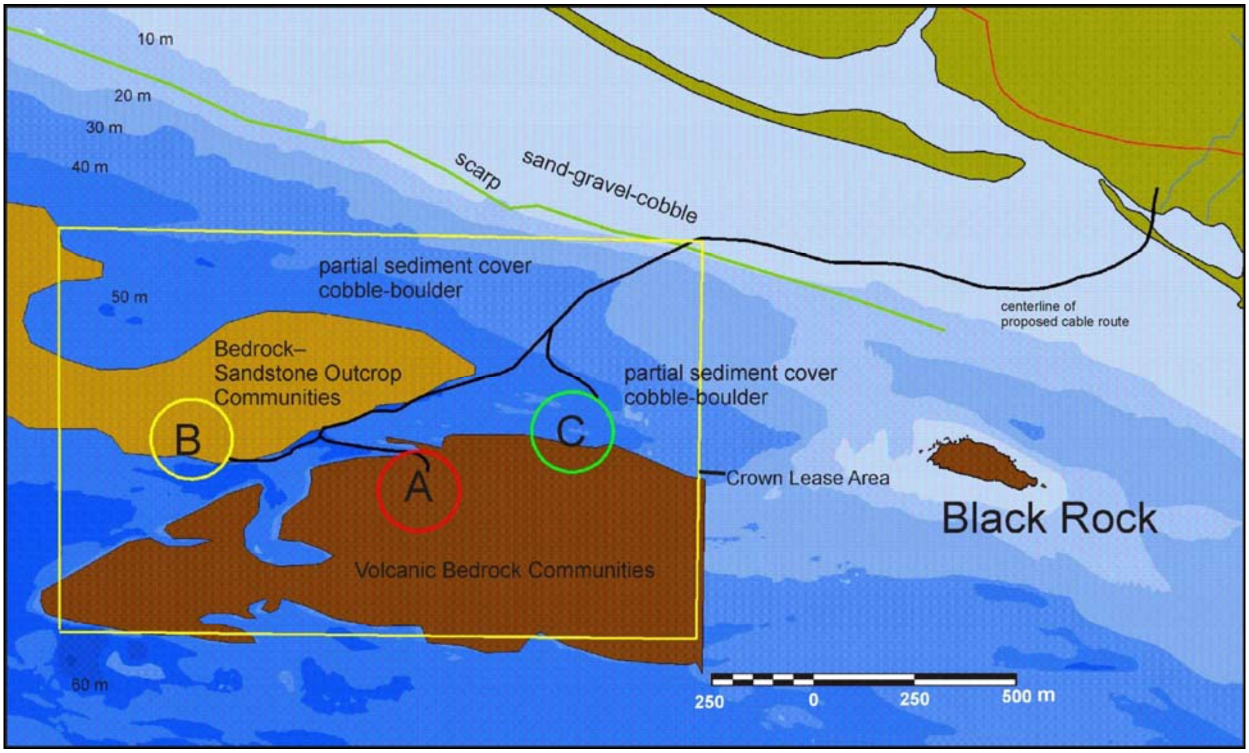


Table 3-3 Benthic Communities in the Study Area

Community/Area	Depth (m)[1]	Substrate	Seaweeds	Macrofauna
Unconsolidated Sediments				
Coastal Platform-Intertidal	HWM to MLW	Level gravel to occasional cobble & boulder	Patchy rockweed (*Fucus* sp) & *Ulva lactuca* on flats. Includes *Ascophyllum* in tide pools.	Low abundance of amphipods, periwinkles, barnacles.
Coastal Platform – Subtidal	MLW - 6.5 m	Gravel to cobble	Coralline algae, occasional rockweed (*Fucus).*	Barnacles, bryozoans (*Flustra),* rock surface community.
Slope and toe of Coastal Platform	6.5 - 25 m	Stable gravel to cobble	No seaweeds.	Rock surface community (tube builders).
Shallow Nearshore (Cobble/ Boulder)	25 – 36 m	Cobble to boulder, occasional gravel, minor sand	No seaweeds.	Breadcrumb sponge, sea stars (*Asterias),* bryozoans (*Flustra)*, rock surface community (tube builders), mobile epifauna (*e.g.,* hermit crabs).
Bedrock				

Community/Area	Depth (m)[1]	Substrate	Seaweeds	Macrofauna
Offshore Sandstone Bedrock ridges	36 – 50 m	Rough sandstone/mudstone ridges separated by bands of cobble and boulder	No seaweeds.	Breadcrumb sponge, seastars (*Asterias, Henricia*), rock surface community (tube builders (*e.g.,* amphipods, *Jassa* sp.), hydroids, attached bivalves (*e.g., Pandora*).
Offshore Volcanic Bedrock Plateau	27 - 33 m	Rough basalt commonly overlain by smooth basalt boulders	No seaweeds.	Breadcrumb sponge, encrusting sponges, barnacles, sea anemones (*Stomphia),* seastars *Henricia* sp., patchy surface tube builders (amphipods/polychaetes), barnacles.
1. Depth below mean low water (MLW)				

<u>Shallow Unconsolidated Gravel</u>

In the immediate subtidal zone on the longshore shelf, an area of encrusting coralline algae and attached seaweeds (*Fucus, Chondrus)* occurs, populated by surface dwelling organisms (upright bryozoans, *Flustra foliacea,* barnacles (*Balanus improvisus),* sea stars (likely *Asterias* sp) and presumably other typical attached and mobile organisms. Down the seaward slope of the scarp at the edge of the shelf, from depths of about 7 m to 25 m, apparently fairly stable gravel to cobble bottom occurs, lacking seaweeds and upright organisms but with a patchy to continuous, detritus-like coating of tubes or invertebrate organisms, including tube building, surface dwelling organisms such as the amphipod *Jassa falcata.*

<u>Deep Unconsolidated Cobble to Boulder</u>

From the toe of the scarp slope seaward, a zone of unconsolidated bottom with a mixture of clean cobble to boulder-sized rocks occurs. Bottom slopes gradually from about 25 m to 36 m for 500 m before outcrops of sandstone or volcanic bedrock are encountered. Yellow encrusting sponges (*Halichondria panicea*) commonly form in patches on boulders, and erect bryozoan *Flustra foliacea* and attached organisms including ascidians (*Boltenia ovifera),* occur typically on the sides of larger rocks, and barnacles, sea stars, and surface tube-building organisms (*i.e.,* amphipod *Jassa falcata)* also occur. Spaces between the rocks are where finer sand to granule sized sediment accumulates and moves with tidal currents. In the boundary layer on the gravel bottom, bedload movement of granules, pebbles and cobbles has scoured near-bottom surfaces and limited development of attached benthic organisms to 20 cm or more above the seabed.

<u>Deep Sedimentary Bedrock Outcrops</u>

Irregular ridges created by parallel outcroppings of layers of sandstone bedrock and associated siltstones and mudstones, often with unconsolidated cobble to boulder in the spaces between the outcrops, support a benthic community typically including species found in other areas. Dominant species include breadcrumb sponge, barnacles, hermit crabs, a surface coating of tube-building organisms (*Jassa falcata* etc.*)* Depths in the sandstone ridge environment range from 36 to 50 m below MLW, with local variations of 3 - 4 m between ridges. Several rock samples were dredged from this area, which supported the amphipod *Jassa falcata,* hydroids (*Eudendrium arbusculum*), the attached gastropods *Anomia squamula* and *A. simplex,* various polychaete worms, some bivalve spat (early settled and attached stages) and the barnacle *Semibalanus balanoides* (Table 3-4). Some of the mudstones observed at the site had holes similar to those created by boring clams, interpreted however as fossil roots (Fader pers. comm. 2008).

Table 3-4 Benthic Organisms on Rocks Dredged in Sedimentary Outcrops Stations 1 and 7, August 19 & 20, 2009 (number or organisms in brackets)

Station 1	Station 7, Sandstone Rock	Station 7, Basalt Rock
Bryozoan -Flustra foliacea	Hydroid Unidentified	Bryozoan unidentified
Hydroid – Eudendrium arbusculum?	Amphipods: *Jassa falcata* (23), *Corophium insidiosum* (1)	Amphipods: *Jassa falcata* (4)
Ascidian – Ascidia callosa	Barnacles: *Semibalanus balanoides* (43)	Hydroid: *Eudendrium? sp*
	Snails: *Anomia squamula* (1); *Anomia simplex* (1).	Polychaete worm fragment
	Clams: Horse mussel spat - *Modiolus modiolus (1)*	Bivalve spat (2)
	Polychaete worms: *Lepidonotus squamatus* (1); Terebellidae (1); Goniadidae (1); Maldanidae (1); *Spirorbis* (1); Ampharetidae (1)	
	Encrusting sponge, white (1); brown (1)	

Deep Volcanic Bedrock Platforms

A volcanic bedrock platform occurs in the study area at depths of 27 to approximately 33 m. The benthic community on the bedrock platform was similar to that in the sedimentary bedrock areas, dominated by yellow-encrusting sponges, and many of the same groups of organisms as occurred on sedimentary bedrock, including barnacles, tube-building organisms (probably amphipods and polychaetes), but with sea anemones (northern red anemone, *Stomphia* sp.).

Benthic Invertebrate Diversity, Abundance and Feeding Type

Benthic communities exhibit moderate diversity and abundance of organisms reflective of communities adapted to the particular environment at the Project site. Most of the organisms identified in the study were particle or detritus feeders, with the exception of the sea anemone, which feeds on zooplankton, and hermit crabs which are omnivorous. Unlike the nearby Minas Basin, waters at the site have relatively low suspended sediment levels which would not interfere with particle/ suspension feeding. The high turbulence could distribute food particles throughout the water column as a food source for bottom dwelling suspension and detritus feeders.

3.2.6 Marine Fish

The Bay of Fundy supports a productive marine ecosystem, which relies in part on various features of the environment which are unique to the bay, such as the intense mixing and the extensive areas of tidal flats caused by the high tides. The ecosystem which supports the fish and shellfish populations includes marine water quality (described previously in Section 3.2.4), phytoplankton (microscopic plants which grow in the water and are food for other organisms), the seaweeds and other attached and surface dwelling plants, as well as salt marshes, which provide food to invertebrates and fish directly, and indirectly by decomposing or being broken apart to form detrital food chains (described previously in Section 3.2.5, Marine Benthos). Diatoms, microscopic plants which grow on the surface of mudflats, are an important food source for invertebrates such as various clam species, including softshell clams and mud shrimp. Mud shrimp are a keystone species in the Bay of Fundy, serving as food for certain fish and migratory shore birds for which the Bay of Fundy, and in particular the Inner Bay and Minas Basin, are an important food supplier.

Fish utilize the varying habitat structures of the Bay of Fundy, which include rocky bottom ranging from bedrock to cobbles and boulder, to sand and gravel and also muddy substrates. The nature of the substrate influences the types of animals and plants which occur locally, although the various species and ecosystems are extensions of those in nearby areas of the Gulf of Maine at the mouth of the Bay. The large intertidal and subtidal flats of the Basin support large food resources for many fish species, while others likely feed on eggs, larvae and juveniles of a range of species present.

The Inner Bay of Fundy supports large populations of various coastal fish species. Some migrate into the bay for feeding and reproduction, while others are resident in the area throughout the year. Specifically, the Minas Basin is home to a variety of fish, some of which were once exceptionally abundant. At least 50 species have been found in the region. Some animals that live and breed in the basin appear to be locally endemic, including species of jellyfish, crabs, barnacles, planktonic copepods, snails and bivalves. The nearest populations are in the southern Gulf of Maine or the warm, brackish water of the southern Gulf of St. Lawrence.

The Minas Basin is also the gateway to a vast breeding and incubation area. Lobsters for example, migrate through the Minas Passage to lay eggs and propagate their species, such that the Passage acts like a ‘door to the nursery’ for the lobster in this area (Appendix 9; CEF Consultants Inc. 2008; 2009). The channels winding through the salt marshes are also important nursery areas for some species of fish found in the Minas Basin.

Specific information on the migration patterns and vertical location in the water column of fish within the Inner Bay of Fundy, and specifically the Minas Basin is relatively scarce, but general patterns emerge. Most species are expected to remain in the upper water column because they have a preference for light and the high turbidity in the water column limits light penetration within Minas Basin to a depth of about 15 m (Appendix 9; CEF Consultants Inc. 2009). Available information, including historic salmon catches and current fishing efforts, suggest a staging area for many species in the Scotts Bay area prior to passage through the high currents of Minas Channel. A second staging area is likely located near the variable freshwater salt interface for those species moving upstream to spawn. Most anadromous species, with the exception of sturgeon, are most likely concentrated in the near surface water layer, while sturgeon are generally found close to bottom. Information on migration paths suggests that passage into Minas Basin, which is likely to be slower and may involve some movement in and out with the tides, is likely concentrated on the south side of Minas Channel (Appendix 9; CEF Consultants Inc. 2008; 2009). Migration out of Minas Basin into the Bay of Fundy is more likely to occur on the north side and be relatively rapid, with less back and forth movement.

Marine fish of the coastal environment include the following five groups: dermersal (or groundfish), pelagic, invertebrates (or shellfish), diadromous (*i.e.,* anadromous and catadromous species), and exotic warm-water and eastern-arctic species. Anadromous fish are species that are born in freshwater, migrate to the ocean to grow and mature, and migrate back to fresh water to complete their life cycle, while in contrast, catadromous fish are species which grow and mature in fresh water and migrate to the ocean to spawn. For these species, the Bay of Fundy may provide an area for feeding or growing, or provide a pathway between freshwater and saltwater habitats.

In the Bay of Fundy, dermersal species include cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius virens*), Atlantic halibut (*Hippoglossus hippoglossus*), white hake (*Urophycis tenuis*), silver hake (*Merluccius bilinearis)*, wolfish (*Anarhichas* sp.), monkfish (*Lophius americanus)*, lumpfish (*Cyclopterus lumpus*), spiny dogfish (*Squalus acanthias),* American plaice (*Hippoglossoides platessoides*), smooth flounder (*Liopsetta putnami*), witch flounder (*Glyptocephalus cynoglossus*) and winter flounder (*Glyptocephalus cynoglossus*). All dermersal species are carnivorous and feed on benthic invertebrate species such as worms, molluscs and crustaceans, as well as other fish. Dermersal species spend most of their time at or near the bottom of the water column. The depth at which these species are present, in combination with the location and characteristics of the proposed turbine devices will determine their vulnerability.

Cod are a demersal species which feed on invertebrates as juveniles, but then switch to fish at the approximately the age of three when they mature to adulthood (50 cm in length). It is suggested that historical spawning areas for cod on the western side of the Outer Bay are no longer used and recent spawning concentrations have been observed to the west of Grand Manan Island (Hunt and Neilson 1993; Buzetta *et al*. 2003).

Haddock, unlike cod, feed almost exclusively on small invertebrates throughout their lives (Scott and Scott 1988). This bottom dwelling species is found at depths between 50 m and 200 m (> 2^0C). Also unlike cod, haddock is a slow growing species, often not reaching 50 cm in length until they are more than 10 years old (Jacques Whitford *et al.* 2008). An annual migration takes place between the Bay of Fundy where adults feed, and Browns Bank and Jefferys Ledge in the southern Gulf of Maine which is considered the major spawning site for this species (Scott and Scott 1988; Frank 1992; Begg 1998).

Pollock concentrate in feeding areas with strong currents and upwelling at locations like Minas Channel, the Passamaquoddy Bay Passages and off Brier Island (Leim and Scott 1966). The Bay of Fundy pollock population is part of a trans-boundary stock that spawns in the Minas Basin and in the southern Gulf of Maine during winter (Trippel and Brown 1993). Juvenile pollock, commonly called harbour pollock, are abundant along beaches and wharves in the summer (Rangeley and Kramer 1995). Pollock grow rapidly, reaching maturity between 4 and 6 years and a size of 50 cm to 70 cm. Juvenile pollock move offshore to feed on krill and fish after their first year of development (Jacques Whitford *et al.* 2008).

Atlantic halibut undertake an annual migration from deep water in winter to shallow water in summer and back and an annual migration of juveniles and a few adults into the Bay from the Scotian Shelf (Jacques Whitford *et al.* 2008). Young halibut enter Minas Basin in spring where there is an angling fishery for them (Wehrell 2005), while the adults remain in deeper water. Halibut grow relatively quickly, reaching 100 cm in length within 10 years, and can reach up to 700 lbs over 30 - 35 years (Scott and Scott 1988).

White and silver hake feed on crustaceans and other fishes, with silver hake feeding particularly on other gadonids and their own young (Scott and Scott 1988). Hake grow and reach maturity at a rapid rate, reaching 40 cm to 50 cm in length by the age of 3 – 4 years. Hake spawn offshore in the summer months. White and silver hake exist as juveniles in different regions of the Bay, white hake are common in the shallows all around the Bay, while silver hake remain in deep water (Dadswell *et al.* 1984; MacDonald *et al*. 1984; Scott and Scott 1988).

Atlantic wolfish appears to be a resident (non-migratory) and solitary species, commonly encountered over hard bottoms and around large boulders and in holes. Wolfish are a slow growing species unlike hake, reaching maturity when about 40 cm long and requiring 10 years to reach 50 cm in length (Scott and Scott 1988). They are benthic feeders, preferring scallops, and are often a by-catch of the scallop fishery (Jacques Whitford *et al.* 2008).

Monkfish are "anglerfish" that lie partially buried and motionless on the bottom are considered a solitary species, and are well adapted to feed on flatfish. A summer migration of monkfish into the Bay follows flounder movements, a species which they are well adapted to feed on. Monkfish are often stranded on the tide flats of the Upper Bay by the rapidly receding tide (Bleakney and McAllister 1973). They are tolerant to a wide range of temperatures, moving inshore into shallow water during the summer months (Scott and Scott 1988).

Lumpfish are found throughout the Bay of Fundy over hard, rocky bottoms and have an onshore migration in spring for spawning with the males remaining with the eggs until they hatch (Scott and Scott 1988). Young lumpfish are semi-pelagic and are abundant on the surface of the Bay of Fundy during the fall and summer months (Gregory and Daborn 1982).

Spiny dogfish are common both on the bottom and in the water column. They are an ovoviviparous species, with the young feeding and growing off a yolk sac *in utero* before being born alive. Sexually mature and pregnant females are distributed throughout the waters of southwest Nova Scotia and the Bay of Fundy during the summer and fall, but move offshore to deeper waters in the winter (Campana *et al.* 2007). Reports by fishermen and others indicate that large females are most common inshore in shallow regions such as the Upper Bay, and some fishermen report many remain throughout the winter (Campana *et al.* 2007).

Witch and American flounder species commonly occur in deep, cold water habitats, mainly in the Outer Bay of Fundy (Scott and Scott 1988). Winter flounder are seasonally abundant throughout the Bay of Fundy, typically occurring over sand and gravel. Winter flounder spawn inshore during spring (May) all around the Bay, but the main stock is concentrated in St. Mary's Bay and Minas Basin in summer where they support a trawl fishery (Percy *et al.* 1997). Smooth flounder are found exclusively in warm sheltered bays such as the Minas Basin, occurring inshore and moving over the tidal flats at high tide (Scott and Scott 1988).

Pelagic fish are known to travel in large schools and feed between the surface and middle of the water column. Pelagic species form a major component of the fish community in the Bay of Fundy and commonly include Atlantic herring (*Clupea harengus*), mackerel (*Scomber scombrus*), porbeagle shark (*Lamna nasus*), bluefin tuna (*Thunnus thynnus)* and swordfish (*Xiphias gladius*). Herring and mackerel feed on planktonic crustaceans, fish eggs and larvae, while porbeagle sharks feed on other pelagic species as well as squid. Several additional species such as Inner Bay of Fundy Atlantic Salmon, *Alosa sp*. (shad and gaspereau), and striped bass are pelagic when in the Bay of Fundy environment.

Minas Basin herring are a unique population within the Bay of Fundy. Most of the Bay herring are fall spawners, but Minas Basin supports a local spring spawning component, which feeds intensively during gonad maturation up to and including spawning (Bradford and Iles 1992). Spawning areas tend to be at depths less than 5 m and in areas of coarse substrate and algae (Stewart and Arnold 1994), with spawning from Scots Bay east through the Minas Channel to the Central Minas Basin. Herring are a planktivorous pelagic species, depending on copeods and cladocerans, which can be found in the passages of the Bay (Jacques Whitford *et al.* 2008).

Porbeagle sharks, also known as mackerel sharks, commonly occur in the Upper Bay of Fundy, and because they feed on other pelagic species, they often occur in areas where populations of these food species are dense, such as the Minas Basin (Dadswell *et al.* 1984).

Bluefin tuna and swordfish are both pelagic species that primarily exist in the open ocean, only entering the Bay of Fundy periodically (Jacques Whitford *et al.* 2008). While mackerel, a highly migratory species, occurs in the Minas Basin as an adult spawner and as migrating juveniles and adults, moving in and out of Canadian waters each summer (May – October) from their US wintering grounds (Dadswell *et al.* 1984; MacKay 1967).

In the Maritimes, eleven species exhibit a regular migration between the ocean and freshwater in order to mature and reproduce. Of these species all but one are anadromous and spawn in freshwater, while the American eel is a catadromous species which spawns in the ocean. In the Bay of Fundy diadromous species include the Inner Bay of Fundy Atlantic Salmon (*Salmo salar*), Atlantic sturgeon (*Acipenser oxyrhynchus*), shortnose sturgeon (*Acipenser brevirostrum*), American eel (*Anaguilla rostrata*), American shad (*Alosa sapodissma)*, alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), Atlantic tomcod (*Microgadus tomcod*), rainbow smelt (*Osmerus mordax*), striped bass (*Morone saxatilis*) and white perch (*Morone americana*).

Inner Bay of Fundy Atlantic Salmon spawn in freshwater streams where they bury their eggs in gravel during the late fall. The eggs hatch in April and the alevins remain in the gravel for six weeks feeding off their yolk sac and then emerge as parr. The parr remain in freshwater for one to three years before migrating to sea as smolts at a size of 13 - 16 cm. Inner Bay of Fundy Atlantic Salmon grow and mature while migrating around the North Atlantic and then return to their natal rivers to spawn (Scott and Scott 1988). Most Inner Bay of Fundy Atlantic Salmon and thought to remain within the Bay of Fundy and Gulf of Maine throughout their life cycle (DFO 2008).

Atlantic sturgeon spawns in fresh water, but spends most of their adult life in the marine environment. Spawning adults migrate upriver in May - July in Canadian waters (NMFS 1998). In some areas, a small spawning migration also occurs in the fall. Atlantic sturgeons probably do not spawn every year, though data on spawning intervals do not exist for most populations. Spawning occurs in flowing water between the salt front and fall line of large rivers. Sturgeon eggs, which are highly adhesive, are deposited on the bottom, usually on hard surfaces, such as cobble (Smith and Clugston 1997). Hatching occurs in 4 to 6 days and the yolksac is absorbed in about 10 days, after which the young assume a demersal existence. Juvenile sturgeons are thought to gradually move downstream into brackish waters, and remain resident in estuarine waters for months or years. Upon reaching a size of approximately 76 - 92 cm (3 – 5 years in warm estuarine waters), the subadults may move to coastal waters (Murawski and Pacheco 1977) where they may undertake long range migrations. At sea, sturgeons feed on various benthic infauna (Scott and Scott 1988; Stein *et al*. 2004). They may reach a length of 480 cm and do not attain maturity until they are 15 or 20 years of age (Scott and Scott 1988). An annual migration occurs through the Bay of Fundy, utilizing the extensive tidal flats inside the Minas Basin as feeding habitat (Armitage and Gingras 2003). The shortnosed sturgeon however, is an estuarine species confined to the Saint John estuary and would be highly unlikely in the Minas Basin or Minas Passage (Dadswell 1979).

Americal eel is a catadromous fish that lives and grows in estuarine or freshwater but returns to the ocean east of the Bahamas to spawn. The larvae arrive onshore all around the Bay in May after drifting North in the Gulf Stream. Eels are common in almost all freshwater and estuarine habitats in the Maritimes and feed on any fish or invertebrate that can capture (Scott and Scott 1988). Eels grow at a relatively slow rate, reaching reproductive age when they are between 8 and 10 years and are between 80 cm to 100 cm in length (Jessop 1996).

American shad are abundant in the Bay of Fundy as a result of the region serving as a summer nursery and as the northern terminus for the costal migration of the species. Fish that spawn in the Bay's rivers mix with migrants from other stocks that spawn further south along the US seaboard. Most major rivers of the Bay support spawning populations. Spawning migrations begin in April with eggs laid above the head of tide in

June and spent adults moving downstream in July. Juveniles migrate seaward during September and October at a size of 80 - 110 mm and the adults return to the natal river in four to five years at a size of 50 - 40 cm. The abundance of shad in the Inner Bay of Fundy reaches high levels between June and October, as a result of the complexity of their coastal migration (Jacques Whitford *et al.* 2008).

The Bay of Fundy supports two species of river herring; the alewife and the blueback herring. The proportion of these species varies between river systems, with gaspereau making up most of the fish in the Black river system and both species comprising the run in the Avon river system (McIntyre *et al*. 2007). It is likely that these species undertake similar feeding migrations in the Bay as the American shad, following the tidal circulation, over the course of the summer, before returning to their natal rivers to spawn in the next season. It is thought that many species of fish may move in relatively large groups following tidal currents as they approach their natal rivers or as they undertake feeding migrations (Dadswell *et al.* 1984).

Tomcod spawn during the winter months (December – January), laying eggs on gravel substrates in estuaries or above the head tide, and eggs hatching in late winter (Scott and Scott 1988). Larvae drift downstream and begin to grow rapidly, settling into the fringe of the intertidal zone by late summer (Dadswell *et al.* 1984). They may reach up to 25 cm in length over the first two years, rarely living longer than 4 years (Scott and Scott 1988).

Rainbow smelt are abundant throughout the Bay of Fundy. Smelt migrate up virtually every brook, stream and river to spawn in early spring (April to May). They grow and mature relatively quickly reaching 13 – 20 cm in length during the first 2 or 3 years of their lives (Scott and Scott 1988). This species spawns close to the tide head of freshwater streams, eggs develop quickly (1 – 2 weeks) and larvae descend downstream into estuarine areas for a period of 2 to 3 months (Jacques Whitford *et al.* 2008).

Striped bass occur throughout the Bay of Fundy and spawn in the upper tidal reaches of larger rivers and in freshwater. Juveniles remain in the estuary for their first year and then move progressively seaward. Similar to shad, bass that spawn in the Bay's rivers and lakes mix with migrants for other stocks that spawn further south along the US seaboard (Jacques Whitford *et al.* 2008). They begin migrating long distances up and down the North American east coast in the summer months once they are approximately 3 years old. Shad feed on invertebrates and fishes, growing rapidly reaching 35 – 50 cm in length by 4 – 6 years of age, commonly reaching lengths of 80 – 130 cm (Scott and Scott 1988).

White perch is closely related to the striped bass, living in isolated populations in estuaries throughout the Bay of Fundy. They are semi-pelagic and feed on plankton, insects and other small fish species (Scott and Scott 1988). Perch are a long lived and slow growing species, small is size, rarely reaching lengths more than 30 cm (JW 2008).

Most of the American shad from east coast waters spend the summer in the basins of the Inner Bay of Fundy. More than 40 species of fish can be considered regular residents, some of the more common being Atlantic herring, alewife, blueback herring, American shad, smelt, Atlantic tomcod, Atlantic silverside, windowpane, smooth and winter flounder, striped bass, Inner Bay of Fundy Atlantic Salmon, and American eel. Waters are productive despite high turbidity and reduced phytoplankton production, because of the high abundance of zooplankton, which feed on detritus from salt-marsh grasses in suspension in the water. The mud flats are home to invertebrates, including numerous species of polychaete worms; softshell clams; intertidal snails; and crustaceans, including the tube-dwelling amphipod *Corophium volutator* (a small shrimp which is food for migratory shorebirds). Several species of flatfish, which live in the deeper water, come into the tidal flats and streams to reproduce and feed. Inshore concentrations of Atlantic halibut at one time occurred in Minas Basin.

Generally, invertebrates are composed of crustaceans, molluscs, echinoderms and marine worms. Invertebrate species in the Bay of Fundy include American lobster (*Homarus americanus*), Jonah crab (*Cancer borealis*), rock crab (*Cancer irroratus*), sea scallops (*Placopecten magellanicus*), soft-shell clam (*Mya arenaria*), periwinkle (*Littorina littorea*), short-fin squid (*Illex illecebrosus*), long-fin squid (*Loligo pealei*), sea urchin (*Strongylocentrotus droebachiensis*), orange-foot sea cucumber (*Cucumaria frondosa*), bloodworm (*Glycera dibranchiate*), sandworm (*Nereis virens*), and clamworm (*Nereis* sp.).

The American lobster is a relatively fast growing crustacean that attains maturity at between 5 and 10 years of age (Cobb 1976), but lobster from the Bay of Fundy are slower growing than those found in other regions of the Maritimes because of the relatively cold water in most of the Bay. American lobster is fished commercially in all parts of the Bay of Fundy except the extremely turbid waters of Cobequid Bay and inner Cumberland Basin.

Jonah and rock crabs are medium-sized crustaceans that occur over rocky/ gravel bottom substrates along with American lobster. They have a life history similar to lobster; Jonah crabs are the larger species, maturing at a size of 80 - 100 mm carapace width. The fishery for Jonah crab is located in 50 - 300 m depths south of Grand Manan and on the Middle Ground off Yarmouth (Robichaud and Frail 2006). Rock crab is mainly caught in St. Mary's Bay, Annapolis Basin and Passamaquoddy Bay in depths less than 50 m.

A number of fish species found within the Bay of Fundy are considered to be at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) including the porbeagle shark and the Inner Bay of Fundy Atlantic Salmon (listed as Endangered), the striped bass (listed as Threatened), and the Atlantic cod, shortnosed sturgeon and the Atlantic wolfish (listed as a species of Special Concern). Marine species at risk which are likely to occur within the proposed Project area are discussed in Section 3.2.9 of this report.

3.2.6.1 Fish Movements within Minas Basin

This section focuses on the migrations and movements of major species within Minas Basin. The emphasis is on the movement of adult fish present in Minas Basin either to feed or to spawn.

Information on fish movements within the Bay of Fundy are drawn primarily from Parker *et al.* (2007) and Jacques Whitford *et al.* (2008). Additional information on estuarine migration and behaviour of species similar to those found in the Bay of Fundy is drawn primarily from Jacobson *et al*. (2004), which describes research on the Lower Connecticut River between 1973 and 2003.

For anadromous species such as Inner Bay of Fundy Atlantic Salmon, shad, striped bass, gaspereau and sturgeon, the homing instinct to spawn provides strong motivation for behaviour (Hasler 1967). Water velocity is one of the primary cues in spawning migrations, but chemical characteristics of the water are thought to modify the specific response to water velocities (Stasko *et al*. 1973). For example, transition from salt to freshwater requires change in osmotic regulation within the fish, which usually requires the fish to stage near the transition between saltwater and fresh. Frequently a group of migrating fish may contain a mix of spawning and feeding fish, with only some of the fish entering freshwater to spawn.

The general movement of anadromous fish within the Bay of Fundy appears to follow that for shad, in which fish tend to enter Minas Basin on the south and leave along the north, responding to velocity patterns established by the Coriolis force. Where acoustic telemetry of fish has tracked movements in estuaries, movement is generally influenced by tide and wind conditions, with considerable movement back and forth with tidal changes (Stasko *et al*. 1973; Leggett 2004).

<u>Inner Bay of Fundy Atlantic Salmon (*Salmo salar)*</u>

Of the salmon stocks within Minas Basin, only the Gaspeau River has an early run of predominantly two sea winter fish (Parker *et al.* 2007). Inner Bay of Fundy Atlantic Salmon, as well as other species may 'stage' along the Scotts Bay shore south of Cape Split before entering Minas Basin (Parker *et al.* 2007). A science review of potential impacts of small-scale tidal generation projects in the Bay of Fundy felt that Inner Bay of Fundy Atlantic Salmon were most likely to be found in the near surface waters based on available information, but agreed that vertical distribution of salmon in the water column was not well-documented (DFO 2008b).

<u>American shad (*Alosa sapodissma)*</u>

Most shad found in Minas Basin in the summer spawn in US rivers to the south, but local spawning runs begin in April in most Bay of Fundy rivers; spawning occurs during June and spent adults migrate downstream in July (Jacques Whitford *et al.* 2008).

Between 1967 and 1969, 230 shad were fitted with ultrasonic tags in the Lower Connecticut River. Migration upriver ranged from on average of 20 km per day immediately following tagging to 27.2 km per day for subsequently tracked shad. Corresponding rates for downriver migrations were 33 and 21.5 km per day. Migration rates were reduced in the area of the salt-freshwater inteface. Fish in the estuary tended to meander near the salt-freshwater interface, moving upstream and downstream for days. This was assumed to reflect adjustment in osmotic regulation before entering freshwater (Leggett 2004).

Studies on shad in the lower Connecticut River from 1974 to 1987 indicate that recruitment appeared to be established by the end of the larval period. Populations of striped bass, shad and blueback herring also occur in the lower Connecticut River. Analysis of data on fishing rates, environmental conditions and fish abundance led to the conclusion that reduced abundance of shad and blueback herring was likely related to predation by an increased population of striped bass, based on food habitats and size frequency of striped bass and changes in abundance of the three species (Savoy and Crecco 2004).

<u>Striped bass (*Morone saxatilis)*</u>

The Shubenacadie River supports the only remaining spawning population of striped bass in the Bay of Fundy. No evidence of reproduction has been recorded in previously existing spawning populations of striped bass in the Annapolis or Saint John Rivers for about 30 years.

Striped bass were tracked using acoustic telemetry in the Miramichi River estuary during two consecutive spawning seasons in 2004 and 2005. In both years, prespawning striped bass staged in the lower and middle sections of the Miramichi River estuary downstream from the spawning area. Males and females moved in synchrony from the staging area to the spawning grounds in the Northwest Miramichi River (Douglas *et al.* 2009).

<u>Sturgeon (*Acipenser sp.)*</u>

Both Atlantic and shortnose sturgeon are found in the Bay of Fundy, but only Atlantic sturgeon are considered common within Minas Basin.

Atlantic sturgeons are found in the estuary of the Connecticut River and these fish are thought to spawn in the Hudson River and enter the Connecticut River estuary to feed. Shortnose sturgeon, however, are relatively abundant in much of the lower Connecticut system (Gephard and McMenemy 2004).

Sixty shortnose sturgeon had ultrasonic tags surgically implanted from 1988 through 2000, with 45 of these providing useful long-term (> 60 days) information. Several transmitters provided information over two or more consecutive spring seasons. Sturgeon movements downriver into the estuary were rapid and directed, with individual fish moving up to 30 km per day. Once in saline waters, however, movements were much slower. Adult shortnose sturgeon can tolerate both high salinities and rapid changes in salinity. In contrast to behaviour seen in other river systems, the most adult fish were found in upriver areas well above any influence of salt water during the winter months (Savoy 2004). Sturgeon in the estuary were found to feed on a wider variety and larger quantity of taxa than sturgeon collected upriver; fish in the estuary consumed almost six times the total wet weight and eight times the total volume of food (Savoy and Benway 2004).

Shortnose sturgeons appear to be a social fish, exhibiting schooling (or shoaling) behaviour particularly in areas where there are strong currents. Feeding along the bottom, their preferred diet is small crustaceans and insects in particular, soft shelled clams (COSEWIC 2005).

3.2.7 Marine Mammals and Sea Turtles

Seabird and Marine Mammal observations were undertaken on four occasions in 2008 during the course of field survey work. Incidental seabird and marine mammal observations were made during surveys in February and March 2009, and dedicated observers made observations on the other two surveys (one biologist in July and a team of two biologists in October 2008). The July and October surveys used standardized seabird and marine mammal observation protocols. Seabird and Marine Mammal observations are reported in Appendix 7: Envirosphere 2009c Seabirds and Marine Mammals, however no marine mammals were observed during these surveys.

Seven marine mammal species (which include cetaceans - whales, dolphins, and porpoises - and seals) commonly occur within the Bay of Fundy. Another twenty-one species can occur occasionally or accidentally be found due to their distribution in northwest Atlantic waters. Species commonly found within the Bay are the Humpback, Finback, North Atlantic Right and Minke whales as well as white-sided dolphin, harbour porpoise and harbour seals. Most species are migratory, entering the Bay seasonally for breeding and feeding, while some species are present year round in offshore waters. Three species (harbour seal, grey seal and harbour porpoise) are present year round in the Bay of Fundy. Three sea turtle species, the Leatherback, Atlantic Ridley, and Green Sea Turtle occur offshore in the western north Atlantic and potentially could occur accidentally in the Bay of Fundy. The most common is the Leatherback, which occurs in offshore areas of the continental shelf off Nova Scotia in the summer.

The Minas Channel, Minas Passage, and Minas Basin are not normally frequented by cetaceans. Waters are generally shallow and few whales are observed here (Kent pers. comm. 2009). Databases maintained by DFO containing sightings and strandings for the East Coast, contain only two whale sightings in the study area; a finback whale in 1967, and a humpback whale in 2003, and no strandings. It should be noted that these databases are not well-supported by contributors of sightings information and likely give an inaccurate picture of abundance.

DFO was contacted regarding marine mammal sightings in the Project area (Corrigan pers. comm. 2009). DFO indicated three whale sitings in the last 45 years: one fin whale, one humpback whale and one beluga whale; the closest was the beluga whale sighting in 2008 was in the Advocate Harbour area, which is approximately 35 km west of the Project site. It is likely that a range of cetaceans, including seals also occur in the study area from time to time. Fishers in the Halls Harbour area have reported seeing small pods of 'porpoises' (probably white-sided dolphins) in Minas Channel and Minas Basin, and seals basking on shore east of Halls Harbour. . This species is a stray from the St. Lawrence Estuary population and is obviously far afield. Limited seabird and marine mammal watches on cruises in support of the baseline study for the Tidal Power Demonstration Project failed to make any sightings of marine mammals in the study area.

Background information on marine mammal and sea turtles and their occurrences for the Bay of Fundy and the east coast are summarized in Tables 3-5 and 3-6. Seven species of marine mammals commonly occur in the Bay of Fundy; five species and the leatherback sea turtle may occasionally occur (Table 3-5); and sixteen species do not normally occur in the Bay of Fundy but could be present extremely rarely as strays (Table 3-6).

Table 3-5 Characteristics of Cetacean, Seal and Sea Turtle Species Occurring in Eastern Canadian Waters, and Occurrence in the Bay of Fundy

Species	Characteristics
Commonly Occurring Species	
Humpback Whale (*Megaptera novaeangliae*)	Humpback Whale (*Megaptera novaeangliae*) is a common whale found over most east coast waters most of the year (May-Dec). They would be most commonly found in Nova Scotia waters while they are feeding during the summer and often observed in groups of 1 - 3 to numerous on breeding or feeding grounds.
Finback Whale (*Balaenoptera physalus*)	The Finback Whale (*Balaenoptera physalus*) is found in all oceans and throughout the area year-round and is the most common large whale in the Bay of Fundy. Several stocks are known to occur in the Maritimes; one stock winters off the Atlantic coastline, while another stock can be seen in the summer along the Scotian Shelf, both feeding on capelin and krill. They can be found alone, in pairs, 3 - 7 and up to 100 or more on feeding grounds and are listed by COSEWIC as a species of concern.
North Atlantic Right Whale (*Eubalaena glacialis*)	The North Atlantic Right Whale (*Eubalaena glacialis*) is a large whale occasionally seen off southern Nova Scotia and in the Bay of Fundy and US east coast waters from June to November. It can be found alone or in small groups with occasional high concentrations (5 - 30) and typically feeds in the Bay of Fundy (NB and NS sides), along the Scotian Shelf, and in the Gulf of St. Lawrence from summer to fall. They are listed by COSEWIC as an endangered species.
Minke Whale (*Balaenoptera acuterostrata*)	The Minke Whale (*Balaenoptera acuterostrata*) is one of the most commonly seen whales on the east coast and is the smallest of the baleens whales. It is observed in groups of 1 - 3 and in large groups when feeding as well as noted with the bay from May until late fall and generally in east coast waters year-round.
White-sided dolphin (*Lagenorhynchus acutus*)	White-sided dolphins (*Lagenorhynchus acutus*) are common during the summer (June-September) in the Bay of Fundy and in areas with high seabed relief and along the edge of the continental shelf. They are often seen traveling in groups of 5 - 50 or larger group sized offshore as well as with other dolphins and whales. They are known as fast swimmers and for their aerobatics and calving occurs during June and July.
Harbour Porpoise (*Phocoena phocoena*)	Listed as a species of concern, the Harbour Porpoise (*Phocoena phocoena*) is a small distinctive porpoise found in coastal areas from summer to fall. It commonly breeds in July - August and found alone or in small groups of 2 - 20. It moves to offshore waters in the winter.
Harbour seal (*Phoca vitulina*)	The Harbour seal (*Phoca vitulina*) is a small coastal seal occurring throughout the Nova Scotia coastline including shelf waters and is listed under COSEWIC as Data Deficient. It can be found alone, or in small groups breeding groups (May - June)

Species	Characteristics
	and larger groups on shore and is present in the Bay year round.
Species which Occasionally Occur	
Sei Whale (*Balaenoptera borealis*)	The Sei Whale (*Balaenoptera borealis*) can be found year-round in shelf and oceanic waters of the east coast. They are observed in groups of 2 - 5 or occasionally in larger large groups.
Sperm whale (*Physeter macrocephalus*)	The Sperm whale (*Physeter macrocephalus*) occurs worldwide and is regularly sighted in deepwater off the continental shelf of Nova Scotia and New England year-round. It can be found in groups of 1 - 50 and may occasionally wander into the bay.
Long finned Pilot Whale (*Globicephala melaena*)	Long finned Pilot Whale (*Globicephala melaena*) occur off coastal Nova Scotia and the Scotian Shelf from mid-March to late November and are often observed in groups of 10 - 50 and up to 500 individuals.
White-beaked Dolphin (*Lagenorhynchus albirostris*)	White-beaked Dolphin (*Lagenorhynchus albirostris*) is a common dolphin in the North Atlantic found widely in cooler continental shelf waters, especially along the shelf edge year round. It can be noted in groups of 2 - 30, up to 150 and can reach 1,500 in numbers.
Grey Seal *(Halichoerus grypus*)	The Grey Seal *(Halichoerus grypus*) is a large seal with concentrations in Gulf of St. Lawrence, coastal Nova Scotia and Sable Island. It can be seen alone, in small groups at sea or up to hundreds on land and ice floes.
Leatherback Sea Turtle (*Dermochelys coriacea*)	Leatherback Sea Turtle (*Dermochelys coriacea*) is a large sea turtle listed as endangered under the *Species at Risk Act*. The species is occasionally sighted on the east coast between June and October, typically from the Bay of Fundy to Sydney Bight, feeding on jellyfish, during a summer migration into northern waters.
Species with Unlikely Occurrence	
Blainville's Beaked Whale (*Mesoplodon densirostris*)	Blainville's Beaked Whale (*Mesoplodon densirostris*) is a warm water species likely linked to warm current systems such as the North Atlantic Gulf Stream as well as deep slope waters (1600 - 3300 feet) (Folkens *et al.* 2002). They may stray into study area in the summer, are often observed in groups of 1 - 6 and up to 12 and are distributed in offshore waters in the winter.
Blue Whale (*Balaenoptera musculus*)	Blue Whale (*Balaenoptera musculus*) is a large whale, which migrates throughout the Maritime waters from mid-spring to winter and found in groups of 1 - 2 and up to 60. It is associated with coastal, shelf and oceanic waters. It is listed by COSEWIC as an endangered species.
Beluga Whale (*Delphinapterus leucas*)	The Beluga Whale (*Delphinapterus leucas*) is commonly in the Arctic (Hudson Strait and Bay and north) with small population in St. Lawrence estuary year-round and found in groups of 5 - 20, 100 and up to the 1000s. A juvenile beluga whale was seen regularly in Advocate Harbour (at the west end of Minas Channel) in the summer 2008. Males of the species often stray from their main population areas (Kent pers. comm. 2009).
Cuvier's Beaked Whale	Cuvier's Beaked Whale (*Ziphius cavirostris*) occurs worldwide except polar waters and is regularly seen in deep Atlantic waters including the edge of the Scotian Shelf

Species	Characteristics
(*Ziphius cavirostris*)	and the Grand Bank. It is usually alone or in small groups (up to 7).
Sowerby's Beaked Whale (*Mesoplodon bidens*)	North Beaked Whale otherwise known as the Sowerby's Beaked Whale (*Mesoplodon bidens*) is a poorly known species, which inhabits cold temperate and sub-arctic deep offshore waters in the North Atlantic. It has been observed in groups of 1 - 2 and 3 - 10 in Sable Gully.
Northern Bottlenose Whale (*Hyperoodon ampullatus*)	Northern Bottlenose Whale (*Hyperoodon ampullatus*) is found in localized populations associated with the continental shelf edge from Labrador throughout Maritime waters (*i.e.,* Gully Marine Protected Area and Whale Sanctuary) year round and in groups of 4 - 10 individuals. It is not abundant and is listed by COSEWIC as endangered.
Killer Whale (*Orcinus orca*)	Killer Whale (*Orcinus orca*) is a broadly distributed species; occasionally sighted in Maritime waters year round and often observed in groups of 3 - 25. They are abundant globally but would be unlikely to occur with the Bay of Fundy.
Pygmy Sperm Whale (*Kogia breviceps*)	Pygmy Sperm Whale (*Kogia breviceps*) is a widely-distributed species with occurrences most likely in warm water and deep water at the shelf edge. They are often seen in groups of 3 - 6 (less commonly 1 - 10).
True's Beaked Whale (*Mesoplodon mirus*)	True's Beaked Whale (*Mesoplodon mirus*) is a rarely seen whale of deep waters occurring in the North Atlantic and several other areas often found in groups of 1 - 3.
Atlantic Spotted Dolphin (*Stenella frontalis*)	Atlantic Spotted Dolphin (*Stenella frontalis*) is a more southerly species normally abundant in US east coast waters, occuring in warm water and deep water at the shelf edge. They are often observed in groups of 5 - 15 or up to 50.
Common Dolphin (*Delphinus delphis*)	Common Dolphin (*Delphinus delphis*) is seasonally present (summer-fall) throughout and common on Scotian Shelf and along shelf edge in groups of 10 - 500.
Bottlenose Dolphin (*Tursiops truncatus*)	Bottlenose Dolphin (*Tursiops truncatus*) is observed occasionally in east coast waters in summer but a more or less regular occupant (year round) of the shelf edge south of Cape Sable. They are found in groups of 1 - 10 inshore and 1 - 25 or up to 500 offshore.
Risso's Dolphin (*Grampus griseus*)	Risso's Dolphin (*Grampus griseus*) occurs worldwide in tropical and warm temperate waters, principally deep offshore waters. They are found in groups of 3 - 50 (less common 1 - 150 or even several thousand).
Striped Dolphin (*Stenella caeruleoalba*)	Striped Dolphin (*Stenella caeruleoalba*) is a common dolphin in the northwest Atlantic, reported typically in deep water along and seaward of the continental shelf edge often in groups of 10 - 500 (1 - 3,000).
Harp Seal (*Phoca groenlandicus*)	Harp Seal (*Phoca groenlandicus*) is a common seal of northern parts of the Canadian east coast, at sea, around ice edges and on ice from winter to spring. It can be found in groups of 2 - 5, occasionally 1 - 12 and in large groups on ice when pupping or moulting and when feeding in water.
Hooded Seal (*Cystophora*	Hooded Seal (*Cystophora cristata*) is a northern species which ranges south along pack ice to Gulf of St. Lawrence and off Newfoundland. It is solitary except during

Species	Characteristics
cristata)	breeding and moulting season and unlikely to occur within the bay.
Ringed seal (*Pusa hispida*)	Ringed seal (*Pusa hispida*) is a common seal throughout the arctic and can extend into waters off Nova Scotia. They can be found solitary or in small groups.

Table 3-6 Species of Marine Mammals Potentially Occurring in the Bay of Fundy

Species		Occurrence	Time in Bay	COSWEIC	SARA
Seals	Harbour Seal (*Phoca vitulina concolor)*	Common	All year	Not at risk	
	Grey Seal (*Halichoerus grypus*)	Occasional	All year	Not at Risk	
	Harp Seal (*Phoca groenlandicus*)	Unlikely	Unpredictable	Not Assessed	
	Hooded Seal (*Cystophora cristata)*	Unlikely	Unpredictable	Not at Risk	
	Ringed Seal (*Pusa hispida*)	Unlikely	Unpredictable	Not at Risk	
Dolphins and Porpoise s	Atlantic Harbour Porpoise (*Phocoena phocoena*)	Common	All year	Special Concern	
	Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)	Common	Jun-Oct	Not at Risk	
	White-beaked Dolphin (*Lagenorhynchus albirostris*)	Occasional	All year	Not at Risk	
	Atlantic Spotted Dolphin (*Stenella frontalis*)	Unlikely	Unpredictable	Not at Risk	
	Bottlenose Common Bottlenose Dolphin (*Tursiops truncatus*)	Unlikely	Summer	Not at Risk	

Species		Occurrence	Time in Bay	COSWEIC	SARA
	Common Dolphin (*Delphinus delphis*)	Unlikely	Summer-fall	Not at Risk	
	Risso's Dolphin (*Grampus griseus*)	Unlikely	Unpredictable	Not at Risk	
Toothed Whales	Long-finned Pilot Whale (*Globicephala melaena*)	Occasional	Mid-March-late November	Not at Risk	
	Sperm Whale (*Physeter macrocephalus*)	Occasional	Year-round	Not at Risk	
	Beluga Whale (*Delphinapterus leucas*)	Unlikely	Unpredictable	Threatened	
	Killer Whale (*Orcinus orca*)	Unlikely	Year-round	Data Deficient	
	Northern Bottlenose Whale (*Hyperoodon ampullatus*)	Unlikely	Year-round	Endangered	
	Pygmy Sperm Whale (*Kogia breviceps*)	Unlikely	Unpredictable	Not at Risk	
	North Atlantic Beaked Whale (Mesoplodon bidens)	Unlikely	Unpredictable	Special Concern	
Baleen Whales	Blainville's Beaked Whale (*Mesoplodon densirostris*)	Unlikely	Summer	Not at Risk	
	Cuvier's Beaked Whale (*Ziphius cavirostris*)	Unlikely	Unpredictable	Not at Risk	
	True's Beaked Whale (*Mesoplodon mirus*)	Unlikely	Unpredictable	Not at Risk	

	Species	Occurrence	Time in Bay	COSWEIC	SARA
	Finback Whale (*Balaenoptera physalus*)	Common	May-Dec	Special Concern	
	Humpback Whale (*Megaptera novaeangliae*)	Common	May-Dec	Threatened	
	Minke Whale (Balaenoptera acutorstrata)	Common	May-Nov	Not at Risk	
	North Atlantic Right Whale (*Eubalaena glacialis*)	Common	Jun-Dec	Endangered	
	Sei Whale (*Balaenoptera borealis*)	Occasional	Year-round	Data Deficient	
	Blue Whale (*Balaenoptera musculus*)	Unlikely	Mid-spring-winter	Endangered	
					Sources: JW 2008; Envirosphere Consultants Ltd. 2006; LGL Limited 2005; Folkens *et al*. 2002.

Sources: JW *et.al* 2008; Envirosphere Consultants Ltd. 2006; LGL Limited 2005; Folkens *et al*. 2002.

3.2.8 Marine Birds

Many species of birds rely on coastal waters for survival, primarily for the food provided (fish and plankton) and the protection from predators afforded by islands and cliffs along the coast. The Bay of Fundy supports coastal seabirds (gulls, terns, cormorants, and alcids such as puffins and guillemots) which nest and rest in coastal areas. Occasional representatives of oceanic species (fulmars, shearwaters and petrels) which typically occupy offshore oceanic waters and spend much of their lives at sea, may stray into the area or be carried into it from the Gulf of Maine and other areas by storms. Coastal waterfowl include ducks and geese, including species primarily associated with freshwater such as the common loons.

Minas Basin and areas of the outer Bay of Fundy near Briar Island are important areas supporting waterfowl and shorebirds (Hicklin and Smith 1984) and Minas Basin is particularly important in shorebird migrations. Some of the highest densities of shorebirds occur on mudflats and saltmarshes in Minas Basin in July -

August as they feed to put on fat reserves for a migration to tropical areas. Common shorebirds which pass through the area include semipalmated sandpiper, black-bellied plover, ruddy turnstone, short-billed dowitcher, and least sand piper, while less common species include red knot, dunlin and white rumped sandpiper (Hicklin and Smith 1984). The southern Bight of Minas Basin has been designated as a hemispheric shorebird reserve to assist in protection of critical environments. The migration period of shorebirds with occurs from mid-July to mid-November, during which time species pass through the Minas Passage and use both shoreline (*e.g.,* semi-palmated sandpipers) and offshore areas (*e.g.,* red knot). Shorelines at the Project site and through most of the outer Bay of Fundy extending from Minas Channel are not particularly suitable to shorebird feeding since the shore is predominantly steeply sloping, rocky and with gravel beaches. Mudflats are absent, although many birds will fly through and rest at the site, as well as possibly visiting the salt marsh areas.

Several raptor species including bald eagle and osprey commonly occur along the coasts in the area, the peregrine falcon—an endangered species—which nests on coastal cliffs and the northern harrier (marsh hawk) are commonly associated with coastal salt marshes and farmland.

Bird surveys were carried out July 7 - 9, 2008 and October 1 - 3, 2008 by Envirosphere Consultants. Distances surveyed were 6.6 km in July and 20.7 km in October. Surveys were conducted concurrently with geophysical surveys and generally followed the Canadian Wildlife Service protocol (Wilhelm *et al.* 2008). A watch of five minutes per hour was carried out while the vessel was steaming. Although this frequency is lower than the five minutes per half hour indicated by the protocol; the protocol is designed for continuous lines, generally covering larger areas than the survey conducted. Consequently the data collected in a small area would provide too many data records and as such, the longer spacing of observations is warranted. Incidental observations of seabirds were also made during the August and September underwater video survey and during site surveys in February and March, 2009. Furthermore, marine birds were noted on land and immediately nearshore during site visits on October 2 and October 31, 2008, and April 16, 2009. A few individuals of the common species (*e.g.,* Greater Black Back Gull) were typically present at the time.

Abundance of seabirds and waterfowl in the central Bay of Fundy (Minas Passage and Channel) including Cape Split where the Project occurs, is low in comparison with Outer Bay and Minas Basin (Hughson 1977; Jacques Whitford *et al.* 2008), but the area is occupied throughout much of the year. Black Rock, a prominent island in the vicinity of the project, is a local resting site for gulls and cormorants and possibly other waterfowl (shown in the following illustration), and many birds move through the study area en route to and from the outer Bay and Minas Basin. Occasional strays can also be observed there.

FIGURE 3-9 GREATER BLACK BACK GULLS AND DOUBLE CRESTED CORMORANTS - BLACK ROCK, JUNE 2008

Waterfowl and Shorebirds

The study area, including the Inner Bay of Fundy east of Cape Chignecto, including Minas Channel, Minas Passage and the Minas Basin, supports various waterfowl species. Waterfowl are present mainly in summer with black ducks in particular known to occur close to shore in bays and estuaries such as the St. Croix estuary (Hughson in Daborn 1977). Canada Geese and black ducks overwinter and forage in saltmarshes during spring and fall migrations (Hicklin and Smith 1984) and scoters and common eider ducks also visit Minas Basin during the spring and fall migrations; common eiders may occur in the Bay in fall and winter. Other waterfowl known to occur include dabbling ducks, blue-winged teal, American widgeon and red-breasted merganser (Parker *et al*. 2007). Shorebirds are abundant in July and August, and a 1976 survey estimated 200,000 in the southern bight of the Minas Basin, and approximately 60,000 along the remaining shore of the Minas Basin (Hughson in Daborn 1977). Shorebirds such as semipalmated sandpipers, short-billed dowitchers and seimpalmated and black-bellied plovers are associated with saltmarshes in the late summer and fall. Most shorebirds are largely migratory and associated with mudflats, which are not prevalent within the Minas Channel and Minas Passage although the species probably visit intertidal areas adjacent to saltmarshes and river mouths in the study area. Shorebirds have been observed resting and feeding on Fox Point Beach, Advocate Harbour Beach as well as Portapique Beach (George pers. comm. 2009). Great blue heron colonies occur on islands in Minas Basin (*e.g.,* Pinnacle Island), and the species likely visit saltmarshes and river mouths at the study site, in particular the saline pond near the proposed shore installation, for feeding and resting during seasonal migrations.

Seabirds

Seabirds most commonly occurring within the study area include double-crested cormorants, greater black back gulls, and herring gulls, but a wide range of species can occur (Table 3-7). Black Rock at the study site is a common resting area and high densities occur there periodically, mostly in summer, and all species move throughout the area daily for feeding. Black back gulls have been observed in rafts at the site in February. Breeding colonies of seabirds including cormorants, herring gulls and greater black backed gulls, are present on islands within the Minas Basin and Cape Split (Jacques Whitford *et al.* 2008). East of Cape Sharp, gulls nest on Pinnacle Island (George pers. comm. 2009); and double-crested cormorants nest on Egg Island, Brick Kiln Island near Economy, Pinnacle Island, and Boot Island (Milton pers. comm. 2009). West of the study site on Spencer's Island near Cape Spencer, there are old records of great blue heron, double-crested cormorant, black guillemot (colony), gulls and common eider being present (George pers. comm. 2009; ACCDC 2009). A small colony of double-crested cormorants occurs on Cape Split (Milton pers. comm. 2009).

Table 3-7 Approximate Density of Sea and Coastal Birds, Minas Passage

Species	Number Observed	Density (number/km)
July 7-9, 2009		
Black Backed Gull	10	1.5
Double Crested Cormorant	10	1.5
Herring Gull	3	0.4
Gull Unidentified	3	0.4
Black Guillemot	1	0.2
Common Loon	1	0.2
Northern Fulmar	1*	0.2
October 1-3, 2009		
Herring Gull	1	0.05
Gull Unidentified	3	0.15
Wilsons Storm Petrel	1**	0.05
Bald Eagle	1	0.05
American Crow	4	0.19
* Observed in Minas Basin. ** Unverified sighting.		

Raptors

Bald eagles commonly occur in Minas Basin feeding principally on fish, in particular tomcod (Hicklin and Smith, in Gordon and Dadswell 1984). Known recent nesting sites are on Moose Island (in the Five Islands Area) and The Brothers Island (George pers. comm. 2009).

The American peregrine falcon (*Falco peregrinus anatum*) nests on and spends the summer in the vicinity of cliffs at Cape Sharp (George pers. comm. 2009). The species is federally listed as an endangered species of Special Concern and provincially as a vulnerable species (more detail on this species is included in Section 3.3.3.2, Terrestrial Species at Risk – Terrestrial Fauna). Individuals are known to feed mainly on birds (*i.e.,* black guillemots and other seabirds) often caught in mid-flight. Nesting takes place on steep cliff ledges or crevices; the species breeds during the second year (mid-May), incubation lasts for 32 - 35 days, and nestlings leave the nest after 40 days and remain in the nest area for 3 - 6 weeks after fledging prior dispersing up to 100 km away (SARA 2009). Peregrines migrate south in the fall. The species was re-introduced to the Minas Basin in the late 1980s.

3.2.9 Marine Species at Risk

Species at Risk are those plants or animals whose existence is threatened or which are in danger of being threatened, by human activities or natural events. Species considered to be at risk are selected by provincial, national and international conservation and biological organizations. COSEWIC, under the direction of the Canadian Endangered Species Conservation Council, presently recommends species to be listed under the *Species at Risk Act (SARA)*, and species are also listed at the provincial level.

SARA is the main federal legislation protecting species at risk. Under *SARA* it is an offence to "kill, harm, harass, capture or take" any individuals of a listed species at risk, or to lead to the destruction of its nest, home, or habitat. *SARA* includes instructions to identify species at risk and establishes timetables and procedures for actions relating to the conservation and protection of those species. The *Act* includes a list of species at risk and other species proposed or under consideration for inclusion, developed by COSEWIC, which is formally recognized under the *Act*.

The *Act* also defines critical habitat 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 the recovery strategy or in an action plan for the species."

Particularly important, *SARA* has resulted in a change to the definition of environmental effect under *CEAA*, which now includes impacts on species at risk as environmental effects requiring consideration under *CEAA*. As a result, species at risk are required to be identified in the federal environmental assessment process, and impacts on them considered, and if likely, reported and managed.

The responsibility for species at risk and critical habitat at the federal level lies with three federal departments: Environment Canada, Fisheries and Oceans Canada, and Parks Canada. Parks Canada is responsible for species and critical habitat on lands it manages; Fisheries and Oceans Canada is responsible for aquatic species (*e.g.,* marine mammals, seabirds etc.) and critical habitat in areas other than those managed by Parks Canada; and Environment Canada is responsible for bird species and critical habitat, including migratory birds protected under the *MBCA* (1994).

The term "*species at risk*" refers to an extirpated, endangered or threatened species or a species of special concern, as defined below:

- *Endangered Species*: a wildlife species that is facing imminent extirpation or extinction.
- *Extirpated Species*: a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.

- *Threatened Species:* a wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
- *Species of Special Concern*: a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

From the Atlantic Canada Conservation Data Centre (ACCDC) search, two rare or uncommon marine species may be present within the Project area, as they have been recorded within a 10 km radius of the proposed Project Facilities. These species are presented in Table 3-8.

Table 3-8 Rare and Uncommon Marine Species Recorded by ACCDC within 10 km of the Study Area

Scientific Name	Common Name	ACCDC Rank	NSDNR Rank	COSEWIC Rank
Alasmidonta undulata	Triangle Floater; Heavy-toothed Wedge mussel	S2S3	Yellow	-
Salmo salar	Inner Bay of Fundy Atlantic Salmon	S2	Not Listed	Endangered

One of the species is "yellow" listed by NSDNR indicating that they are sensitive to human activities or natural events. However, based on research conducted for this study, only one of the two marine species at risk recorded by ACCDC could potentially occur in the study area, which is the Inner Bay of Fundy Atlantic Salmon (Appendix 7: Envirosphere 2009c). Other species are unlikely to be present in the study area due to insufficient habitat requirements. In addition, there are several other marine species at risk which occur or could potentially occur in the study area, including:

Inner Bay of Fundy Atlantic Salmon (*Salmo salar*)

Inner Bay of Fundy Atlantic Salmon populations throughout the Maritimes are reduced, but are dangerously low in the Inner Bay of Fundy and rivers along the South Shore of Nova Scotia, where they have been impacted by acid rain. Inner Bay of Fundy Atlantic Salmon spawn in the fall, and eggs hatch in May - June. Juveniles migrate to estuarine waters in the summer.

Striped Bass (*Morone saxatilis*)

Striped bass are an estuarine species, which matures at sea and migrates into freshwater to spawn (early June). During the summer they feed and grow in estuaries and coastal bays while in the fall they are known to migrate upstream again where they overwinter probably to avoid the cold ocean temperatures.

Leatherback Sea Turtle (*Dermochelys coriacea*)

This large sea turtle has been listed as endangered under *SARA*. The species is occasionally sighted on the east coast between June and October, typically from the Bay of Fundy to Sydney Bight, feeding on jellyfish, but they can occur more widely. It is highly unlikely that this species would occur in the Project area.

Harbour Porpoise (*Phocoena phocoena*)

Listed as a species of concern, the harbour porpoise occurs all along the Atlantic Coast and in the Gulf of St. Lawrence from summer to fall, commonly breeding in July - August.

North Atlantic Right Whale (*Eubalaena glacialis*)

The right whale is listed as an endangered species that passes through the area, typically feeding in the Bay of Fundy (NB and NS sides), along the Scotian Shelf, and in the Gulf of St. Lawrence from summer to fall.

Shortnose Sturgeon (*Acipenser brevirostrum*)

Shortnose sturgeon is listed as a species of concern, inhabiting estuaries and coastal rivers of the Bay of Fundy, New Brunswick, predominantly the Saint John River. The species migrates upstream during spring and downstream during fall, and spawn during April - June.

Finback Whale (*Balaenoptera physalus*)

The finback or fin whale is found in all oceans and throughout the area year-round and is the most common large whale in the Bay of Fundy. Several stocks are known to occur in the Maritimes; one stock winters off the Atlantic coastline while another stock can be seen in the summer along the Scotian Shelf, both feeding on capelin and krill. They can be found alone, in pairs, 3 - 7 and up to 100 or more on feeding grounds and are listed by COSEWIC as a species of concern. The species' population was reduced by whaling, although sightings remain relatively common off Atlantic Canada.

American Eel *(Anguilla rostrata)*

Commonly found in estuaries and coastal freshwater, American eel enter freshwater streams as small juveniles (elvers) where they mature. Some overwinter in estuaries while others migrate (August – December) to the mid-Atlantic ocean (Sargasso Sea) to spawn. The population is listed by COSEWIC as Special Concern and is susceptible to habitat alteration, dams, fishery harvest, oscillations in ocean conditions, acid rain and contaminants.

Porbeagle Shark (*Lamna nasus*)

Porbeagle shark are a coastal and oceanic shark, which can be found in waters less than 1 m in depth or as much as 700 m. They live in cold to temperate waters and can be found around the Scotian Shelf as well as in the Bay of Fundy during spring, summer and fall. Mating occurs from late September to November usually in areas such as the Grand Banks, south of Newfoundland and at the mouth of the Gulf of St. Lawrence area and pupping occurs later on in early April to June. Little is known about where the shark overwinters. The population is listed by COSEWIC as endangered and is susceptible to overfishing especially due to a late maturation stage and low fertility rates.

3.3 Terrestrial Environment

3.3.1 Intertidal Environment

Terrestrial and preliminary intertidal site surveys were conducted on October 2, 2008 by biologists P. Stewart and H. Levy of Envirosphere Consultants and botanist J. Jotcham (Marbicon Inc.) (Appendix 8: Envirosphere 2009d). Subsequently a detailed survey of beach areas and the lower intertidal zone was carried out on October 21, 2008 by Envirosphere Consultants (P. Stewart and B. Stewart) and J. Kozak of AECOM Ltd. During the initial survey, study personnel conducted a walkover of the entire site and relevant adjacent areas to determine key physical features, distribution of terrestrial plant communities, and distribution of ponds and wetlands, including salt marshes and fish habitat and beach characteristics. Minnow traps were set in the main saltmarsh/barachois pond for approximately two hours to assess fish populations; fish captured were identified, measured and counted. Water quality measurements were taken in the pond and associated drainage channels using a YSI Model 85 hand-held salinity-temperature-oxygen meter.

The detailed intertidal survey conducted on October 21, 2008, consisted of laying a rope marked in 10 m intervals, across the intertidal zone from the top of the beach ridge to the approximate low tide mark at two locations marking the approximate range suggested for the cable route; taking observations and photographs of the substrate and alongshore in both directions, as well as vertically up the shore in 10 m intervals. The biological community was noted qualitatively at each of the sites and representative samples were taken to support observations made in the field. During both surveys, locations of key features were logged on hand-held GPS units and photographed.

Independent wildlife surveys were not undertaken in support of this EA due to the highly modified nature of the site, however, during both field surveys information was collected regarding the presence of mammals and herpetiles (amphibians and reptiles) if they were encountered. No surveys were undertaken specifically for migratory birds above the low tide level. Observations made by the field team included incidental observations of coastal birds present. Birds in the intertidal areas and terrestrial portions of the Project site were not surveyed. If present, however, some individuals of these species would have been recorded. Additional field surveys for breeding birds will be conducted in June 2009 by qualified biologists.

The terrestrial lands to be utilized of the onshore facilities (Lot 84-PM, PID 25347451) represent a highly modified site, currently utilized for residential purposes. The shore at the site is dominated by several gradually-sloping, flat-topped bedrock platforms separated by ravines, situated above the extreme high water level, and on one of which the shore facilities will be located. The platforms have associated steep seaward slopes which end at the high tide mark in salt marsh habitat. Outwash deposits also occur on the salt marsh margin at the foot of ravines, derived from eroded sediments carried by runoff. The intertidal zone (*i.e.,* below extreme high water and above extreme low water) is dominated by a predominantly gravel barrier beach and beach ridge complex extending from headlands on the east to the mouth of Mill River on the west; and a salt marsh/barachois pond complex between the barrier beach and the uplands. The beach is gradually sloping and flat on its eastern end, but has several major gravel bars towards its western (Mill River) end, behind which several temporary ponds and a semi-permanent intertidal pond have developed.

As presently proposed, the cable route will extend from a underground vault installed in the upland above extreme high tide level, descending the slope in a southerly direction to reach the high tide mark adjacent to the salt marsh. The terrestrial and intertidal cable corridor will be 50 m wide. It will subsequently cross the narrowest part (west end) of the salt marsh complex, passing under an existing drainage channel for the salt marsh and barachois pond, and under the major beach ridge, being trenched across the beach as far as is practical on the lower intertidal zone.

3.3.1.1 Salt Marsh/ Barachois Pond Complex

The intertidal zone at the site is dominated by an intertidal barachois pond/salt marsh complex behind a barrier beach and beach ridge which runs east-west from headlands on the east to the mouth of Mill River on the west. Saltmarsh is a common type of intertidal wetland along the Bay of Fundy, although it's presence in this part of the Bay of Fundy (Project area), where the tides are high and the coastline slopes steeply, is relatively uncommon compared to other areas of the Bay. Salt marsh occurs primarily at the mouths of rivers at high tide mark, and in inlets such as the one fronting the proposed Project installation site. The salt marsh vegetation and associations with the adjacent fresh marsh were typical of salt marshes found elsewhere in the Bay, including Minas Basin, and were comprised similar dominant species.

The marsh is dominated by 'high' salt marsh grass (*Spartina patens*), but includes occasional other species characteristic of salt marshes. Lowest elevations in the marsh and the pond are flooded daily by the tide, with more extensive flooding occurring on spring tides and during storm surge events. The east end of the marsh and areas bordering the upland are fresher, due to surface and ground water runoff from the upland and the major ravine entering at the head of the marsh, with typical 'fresh marsh' plant constituents dominating, including sedges, cattails, and bulrushes. Freshwater wetland vegetation (*e.g.,* irises, *Iris* sp., bulrushes, downy alder) also occurs along the upland edge of the salt marsh on the north side within the study area (*i.e*., below the proposed shore installation), particularly where a ravine meets the salt marsh and at the foot of the escarpment on the edge of the upland (illustrated on the following page). In these areas, intermittent flow from runoff from the upland and possibly groundwater outflow enters the marsh and concentrates along the edge. The ravine has caused a build-up of pebble/gravel to cobble material, sometimes extending out into the marsh, where the material has washed out of the ravine and is generally unvegetated.

Within the salt marsh area, several small inactive gravel bars occur inside the main beach ridge and run parallel to it, likely formed when the area was flooded by earlier storms and extreme high water events. These small bars have been overgrown in places by sparse growth of high marsh grass (*Spartina patens*) but are otherwise free of vegetation. The secondary bars running through the salt marsh have similar composition to the top of the main bar, principally a densely packed, medium to coarse pebble sized shingle.

The salt marsh pond is oval in shape, 90 m x 20 m (0.19 ha in area) (illustrated above) set in the adjacent high marsh. The pond is shallow (~ 30 cm) with mud bottom and patchy growth of aquatic plants including rockweed (*Fucus* sp.). The pond has sharply-cut banks consisting of tussocks of salt marsh cord grass (*Spartina patens*) which also dominates the shore zone around the margin. Freshwater runoff from the adjoining uplands and salt marsh drainage from tidal flooding with seawater enters the pond through a narrow channel (0.3 – 1 m wide) on the east end, creating estuarine conditions (salinities of 23.5 to 26 ppt in the pond and downstream channel; Table 3-9).

FIGURE 3-10 INTERTIDAL AND TERRESTRIAL LANDSCAPE OF THE CABLE ROUTE AND FACILITY

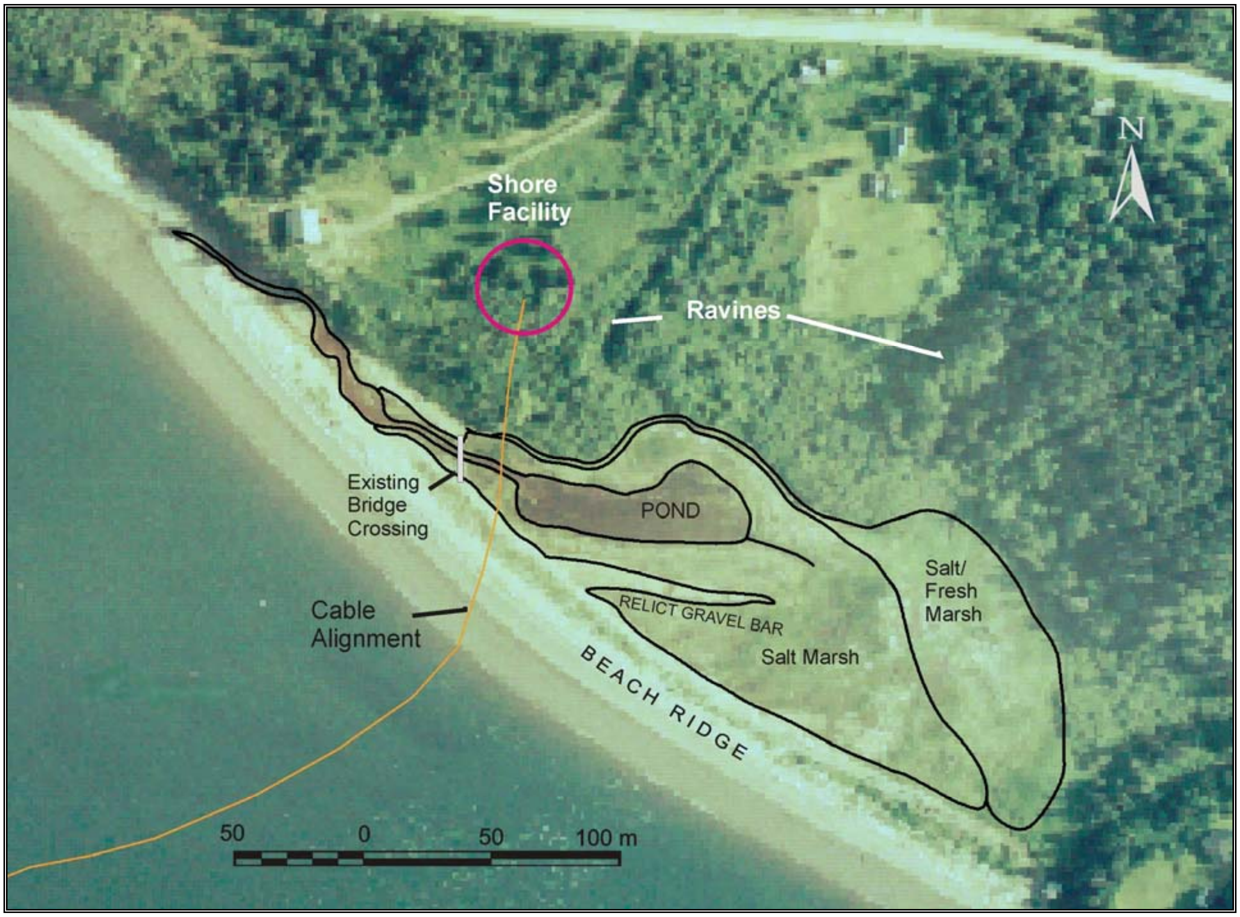


Table 3-9 Salt Marsh Pond and Adjacent Drainage Water Quality Observations

Parameters	Drainage Channel, East of Pond	Mouth of Drainage Channel	Backshore Pond (Edge of Pond at Mid-Point)	Channel below Pond (at Bridge)
Temperature (˚C)	12.4	13.0	13.8	13.8
Dissolved Oxygen Saturation (%)	70.7	50.1	38.8	96.6
Dissolved Oxygen (mg/L)	7.26	7.88	3.36	8.94
Conductivity (µs)	377	660	29,180	30,390
Specific Conductivity (25°) (µs)	564	865	37,090	38,840
Salinity (ppt)	0.2	0.4	23.5	26.0
pH	6.9	--	7.7	--
TSS (mg/L)	7.5	--	22.5	--

The upstream channel is cluttered with debris such as flotsam and pieces of wood, logs etc. The outflow channel from the pond is straight, about 1.5 m wide and 30 cm deep, passing through a narrow band of salt marsh before flowing through a sharply cut channel between the main gravel bar and the upland (illustrated below). Along the downstream portions of the channel there are outcrops of bedrock on the landward side which help to constrain the channel, and patches of marsh peat beneath the edges of the gravel bar, through which the channel has eroded. A second shallow pond 5 m in diameter, less than 30 cm deep and having low salinity occurs in the salt marsh southeast of the main pond.

FIGURE 3-11 INFLOW - EAST END OF BARACHOIS POND IN SALT MARSH

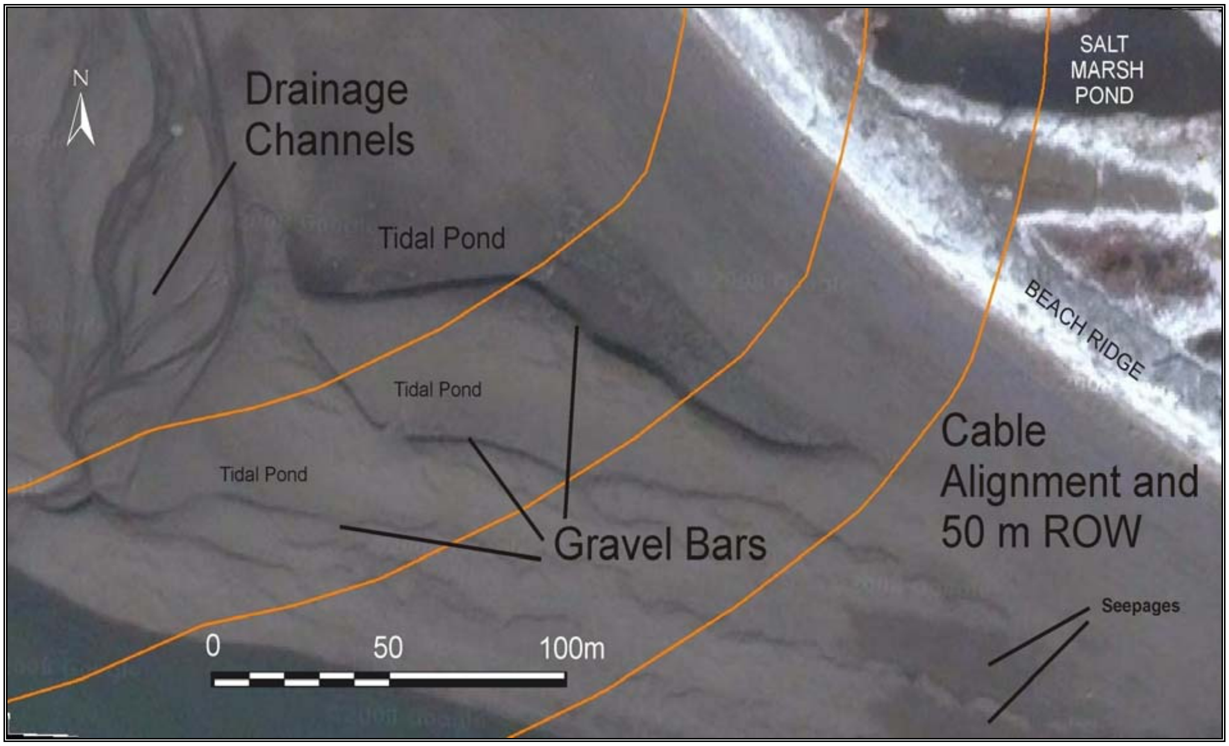
FIGURE 3-12 OUTFLOW - CHANNEL DRAINING SALT MARSH

All the areas of salt marsh and ponds described, as well as fresh marsh areas, are considered to be coastal wetlands under the provincial Wetlands Alteration Approval Policy, and will likely be subject to a provincial Wetland Alteration Approval through NSDNR. Wetland areas are shown in the previous image, *Intertidal and Terrestrial Landscape of the Onshore Cable Route and Facility*, and in Table 3-10.

3.3.1.2 Beach and Beach Ridge Complex

A gravel beach and beach ridge run east-west along the shore at the site, seaward of the pond/ salt marsh complex. The ridge is predominantly made up of small to medium pebble sized, densely packed shingle, with a small component of coarse sand; has a patchy cover of terrestrial vegetation characteristic of upper shore zones; and has accumulated flotsam including drift wood, logs and man-made debris (*e.g.,* rope, lobster traps etc.). The ridge has a fairly steeply sloping seaward face (1:10) transitioning to a more gentle slope (1:20 to 1:30) across the gravel beach. The character of the beach changes from the east end of the study site where it slopes uniformly seaward, to the west end where it is dominated by a series of large gravel bars. The proposed cable route will cross the eastern end of the gravel bar complex (illustrated below). The beach zone at the mouth of Mill River (at the western end of the site) widens into a braided, delta-like fluvial fan.

FIGURE 3-13 BEACH CHARACTERISTICS ALONG ON SHORE CABLE CORRIDOR



Upper levels of the beach consist predominantly of fine small to medium pebble-sized dense shingle, with patches of coarse sand, but substrate on the beach grades into a large pebble to cobble bottom at low water (Table 3-10). The beach zone is devoid of marine plant life except for isolated groundwater seepages, occasional mobile rocks with attached rockweed, and intermittent tide pools that have formed landward of major gravel bars, due to the restricted flow of water off the beach. Seepage areas on the lower intertidal have developed localized growth of sea lettuce (*Ulva sp*.).

Table 3-10 Beach Characteristics along Cable Corridor Transects

Transect	Distance (metres)	Physical Description	Biological Description	Comment
Transect 1	0	Medium to coarse pebble, man-made debris; wood	Patchy upper shore zone terrestrial species (*e.g.,* beach pea, wild rose)	Beach ridge
	10	Medium to coarse sand overlain by fine to medium pebble	No seaweeds present	Slope 1:10
	20	Uniform fine gravel (granule to medium pebble)	"	Several hard packed sand/gravel waves
	30	Coarse sand to fine to coarse pebble	"	Slope 1:25

Transect	Distance (metres)	Physical Description	Biological Description	Comment
	40	Mixed, fine gravel (fine to coarse pebble) to occasional firm cobble	"	Slope 1:30
	50	Mixed coarse sand to medium cobble (10%)	"	"
	60	Coarse granule dominated wave over to medium to large cobble	"	"
	70	Coarse sand to coarse cobble	Occasional sea lettuce (*Ulva* sp) both living and dead plants, on cobbles	"
	80	Predominantly gravel with cobble	Occasional drift rockweed (*Fucus)* and sea lettuce (*Ulva sp)* in pools	Small gravel wave; patchy groundwater seepage
	90	Gravel to cobble, with fine gravel waves	Occasional sea lettuce (*Ulva sp)* and juvenile rockweed (*Fucus)* in seepage areas	Groundwater seepage; fine gravel waves
	100	Gravel to cobble with fine coarse gravel to gravel waves	Drift seaweeds	Groundwater seepage. Approx. mid-tide level. Intertidal ponds upslope of gravel waves
	110	Heterogeneous coarse sand to coarse pebble with occasional fine cobble waves	No biota	Slope 1:30
Transect 2	0	Medium pebble sized shingle	Patchy terrestrial vegetation	
	10	Very coarse sand to fine pebble beach (fine pebble waves over coarse sand base)	No biota	
	20	Coarse granule to fine pebble beach.	No biota	
	30	Fine granule to medium pebble beach	No biota	
	40	Coarse sand to medium pebble beach with occasional large cobble	No biota	
	50	Coarse pebble to fine to medium cobble beach with occasional boulder	Drift rockweed (*Fucus* sp), occasional dead sea lettuce (*Ulva* sp), occasional small	

Transect	Distance (metres)	Physical Description	Biological Description	Comment
			periwinkles (*Littorina* sp)	
	60	Predominantly medium to coarse pebble in mud matrix, with occasional cobble, and small boulder common	Rockweed abundant (50% cover), barnacles on rock surfaces	
	70	Coarse sand to medium pebble, with occasional coarse pebble	Rockweed (*Fucus*) abundant, dead sea lettuce (*Ulva*). Large patches of *Ascophyllum nodosum* in upper part of low area	Slope adjacent to intertidal pond developed above major gravel wave
	80	Predominantly fine to medium pebble with muddy matrix	Rockweed (*Fucus)* abundant (50% cover), barnacles and occasional periwinkles (*Littorina* sp*)*	Edge of intertidal pond
	90	Fine to medium pebble in muddy matrix	Barnacles, juvenile periwinkles (*Littorina littorea)* on rocks	Base of intertidal pond above major gravel wave
	100	Coarse pebble to occasional fine cobble in muddy matrix	Barnacles, attached rockweed (*Fucus*), periwinkles	On secondary slope of gravel wave
	110	Granule to predominantly coarse gravel and occasional cobble	Occasional barnacles on rocks	Shoreward edge of pebble to cobble wave and ridge
	120	Predominantly fine to medium pebble with occasional cobble	No biota	Near crest of large gravel wave
	130	Predominantly fine gravel (fine pebble to medium pebble) with occasional coarse gravel and cobble	Occasional drift rockweed (*Fucus*) and sea lettuce (*Ulva*)	Seaward slope of gravel wave
	140	Predominantly mixed fine to coarse pebble with fine to coarse cobble	Sea lettuce (*Ulva* sp) and rockweed (*Fucus* sp)	Slope of secondary gravel ridge
	150	Fine pebble to coarse cobble with occasional small boulder, behind gravel bar	Occasional barnacles on cobble/boulders; dead sea lettuce (*Ulva* sp.) 50% cover, occasional juvenile rockweed (*Fucus* sp), Occasional small periwinkles	Intertidal pond area above secondary gravel bar
	160	Well-sorted fine to coarse	No biota on ridge. Adjacent	Upshore slope of wave

Transect	Distance (metres)	Physical Description	Biological Description	Comment
		pebble c/w occasional fine to medium cobble	pond has cobble in muddy matrix with dead sea lettuce (*Ulva)* plus abundant rockweed (*Fucus*) on cobbles	is 45º
	170	Mixed coarse sand to coarse cobble with predominantly medium to coarse pebble	Dead sea lettuce (*Ulva* sp); rocks with barnacles; occasional periwinkles (*Littorina littorea)*	Seaward slope of gravel ridge
	180	Coarse pebble to coarse cobble and occasional boulder	Dead sea lettuce (*Ulva* sp); rocks with barnacles; occasional periwinkles (*Littorina littorea);* occasional drift *Fucus*	This area is protected from some wave energy by adjacent gravel waves allowing seaweed development
	190	Coarse sand to occasional small to medium cobble	Occasional drift rockweed; occasional periwinkles (*Littorina littorea* & *L. saxatilis*)	Black River fluvial fan; relatively level in elevation with numerous gravel waves
	205	Coarse sand to fine pebble over occasional cobble to boulder	No seaweeds or animals observed	Appears to be a basal eroded till substrate covered by waves of finer material
	215	Coarse sand to predominantly medium to coarse pebble and occasional cobble	Occasional periwinkles and barnacles	Level terrace behind gravel bar
	225	Predominantly fine to coarse pebble with occasional fine to medium and large cobble	Barnacles on large cobble	Near low tide mark
	235	Coarse pebble to coarse cobble	No seaweeds or animals observed	Normal low water

The complex of large gravel bars is a dominant feature of the mid to low-intertidal zone on the west end of the beach. The bars appear to be moderately stable, in that they appeared in roughly the same position in October 2008 as in a winter satellite image. They have a gradual seaward slope, and a relatively steep upshore slope. In addition, the bars trap the receding tide upshore, creating semi-permanent ponds which have developed low diversity, intermittent tide-pool biological communities. The zone behind the more shoreward bar differs in substrate from the adjacent gravel bar, containing a level muddy gravel to cobble and boulder bottom supports patchy growth of rockweed *Fucus*; the margins have similar substrate and support barnacles, as well as patchy *Fucus* and *Ascophyllum* and small and large sea lettuce (*Ulva lactuca*), the latter which had died off due to the lateness in the growing season. Various invertebrate animal species were also found among the seaweeds and rocks (Table 3-11). A similar, less permanent pond seaward of the main bar supports dense growth of sea lettuce (*Ulva lactuca*) (which had also died off at the time of the survey) as well as some smaller specimens up to about 5 cm in length which were alive and bright green. The west end of the beach, seaward of the bar complex, levels into a low intertidal platform consisting of level cobble with occasional loose small to medium cobbles on the surface. Cobbles and solid surfaces are occasionally occupied by barnacles and attached seaweeds (*e.g.,* rockweeds).

The beach at the site is not designated under the Nova Scotia *Beaches Protection Act.*

Table 3-11 Marine Plant and Animals Species in Intermittent Tidal Pools

Animals	Plants
Amphipods *Hyale nilssoni* *Marinogammarus obtusatus* Isopods *Jaera marina* Barnacles *Semibalanus balanoides* Gastropods *Littorina littorea* *L. obtusatus* *L. saxatilis* Decapods Green Crab (*Carcinus maenas)* Mud crab (*Rhithropanopeus harrisii)*	Rockweeds (*Fucus* sp.*, Ascophyllum nodosum*) Sea lettuce (*Ulva lactuca*)

3.3.1.3 Fish Habitat

The small watercourse identified at the site is a salt marsh drainage channel, extending from the salt marsh pond to the ocean, and is considered to be intertidal fish habitat. It is located below the high tide mark and is flooded by the sea regularly. The channel is shallow and narrow and is not expected to support spawning of any species or any significant movement of freshwater species (trout or salmon could enter the site on a high tide, but would have no spawning habitat), and therefore is not considered to be significant habitat. A salt marsh channel extends east of the pond and curves into the body of the salt marsh where it ends. Intermittent freshwater inflow enters the salt marsh from three ravines, one at the site of the proposed shore facility, and two approximately 50 m and 150 m east of the shore facility respectively; runoff from the ravines and upland slopes disperses in the salt marsh, resulting in development of localized fresh marsh vegetation but no channels through the salt marsh.

The main saltmarsh pond held schools of mumichugs (fish, *Fundulus heteroclitus*). This species was the only one recovered in six, two-hour sets of standard minnow traps at the site. Up to ~140 individuals, 4-5 cm in total length (the dominant size class) were captured per set (average ~51 for 6 sets). Three other size classes, 3 - 4 cm, 6 - 8 and 8 - 10 cm were also present. Two individuals in the 4 - 5 cm size class were captured in the inflow stream.

All salt marsh and associated ponds and fresh marsh, as well as the intertidal zone on the beach, are considered to be Fish Habitat under the federal *Fisheries Act*, administered by DFO. The small channel draining the saltmarsh pond is also fish habitat. Fish habitat features are summarized in the previous image, *Intertidal and Terrestrial Landscape of the Onshore Cable Route and Facility*, and Table 3-10.

The small channel draining the saltmarsh pond is not considered to be a navigable watercourse. The salinities in the pond were estuarine, indicating recent salt water influence and negligible quantities of freshwater entering the pond. The channel is no more than 15 cm deep at low tide and the widest section is about 1.0 m, near the pond. The inlet to the pond (upstream) is about 0.61 m wide and 30 cm deep and appears to be a local drainage channel only. A person cannot walk up it as it is so narrow and convoluted.

3.3.2 Terrestrial Wildlife and Wildlife Habitat

Terrestrial and intertidal site surveys were conducted on October 2 and 21, 2008. All parts of the site were examined from the West Bay Road down to the shore. No quantitative sampling was performed. Given the timing of site selection, terrestrial areas of the site were studied to determine general characteristics of the terrestrial environment only, including the botany surveys in October, 2008. Initial conclusions are that the land area was formerly cultivated and has been abandoned, or is presently used for a residential lawn or hay production. The abandoned lands has resulted in the presence of plant communities indicative of old-field successions, and are believed to be unlikely to support rare or endangered plant species, significant wetlands, or wildlife habitat. No surveys specifically for migratory birds above the low tide level were undertaken. Observations made by the field team included incidental observations of coastal birds present. Birds in the intertidal areas and terrestrial portions of the Project site were not surveyed. If present, however, some individuals of these species would have been recorded. Additional field surveys by qualified biologists are proposed for June 2009 (breeding birds) and another for July - August 2009 to collect additional information on flora and fauna.

The proposed shore facility site and parking area is on a rectangular, gradually sloping plateau elevated about 7 m above the salt marsh level, underlain by bedrock and overlain by glacial till, which runs along the coast at the site. Areas on the plateau proposed for the shore facility and parking area are a combination of old fields and hay fields, connected by grassed walking trails. Old fields are vegetated with plants typical of this environment including grass species, goldenrod, white spruce, white asters, alder, and rose bushes. Seaward, the plateau descends to a steep heavily vegetated escarpment slope where the substrate consists mainly of glacial till and associated soil. The lower parts of the escarpment are vegetated with a dense growth of alders and the upper margin (where it meets the top of the plateau) with a dense fringe of rose bushes.

The upland terrestrial environments at the site had been previously disturbed by agriculture and largely abandoned, resulting in the presence of remnants of fields and colonist species of trees such as white spruce and shrubs, including alders. Black Rock was settled and the shore at the site would have been occupied by farms where land was used for pasture, hay production or tillage. The forest types in the adjacent areas would be a source of colonist species for the old field. Farmland and abandoned farmland commonly extends to the shoreline on the Bay of Fundy, where it is influenced by the more moderate, though cooler temperatures.

Two ravines cut through the plateau adjacent to the site, both to the east of the on-land facilities. Both originate near the West Bay Road and widen gradually to the shore; the larger one (the furthest east of the Project site) had a low flow at the time of the October survey, but the smaller one had negligible flow, presumably from groundwater seepage. Ravine bottoms consist of bedrock and rock fragments, and are vegetated by various shrub and tree species. Under conditions of high runoff, flow is likely to be greater, though intermittent, as evidenced by gravel debris transported into the marsh at the foot of the ravines.

The plant communities at the Project site were found to be typical of abandoned farmland and old-field successions. Davis and Browne (1997) describe old field successions in which common species include white sspruce, tall grasses and perennials. Broad-leaved plants often include sheep-sorrel (*Rumex*), spurry (*Spergula*), plantains (*Plantago* spp.), goldenrods (*Solidago* spp.), yarrow (*Achillea*), dandelion (*Taraxacum*) and thistles (*Sonchus; Cirsium*), as well as persistent perennial herbs including wild strawberry (*Fragaria*), white clover (*Trifolium*) and pearly everlasting (*Anaphalis*). Shrubs on old field successions can include juniper (*Juniperus*), raspberry (*Rubus* spp.), willow (*Salix* spp.), meadowsweet (*Spiraea*) and alder (*Alnus*) (Davis and Browne 1997).

Species in the old field succession found on the upland area proposed for the shore facility, included yarrow, green alder, New York aster, sedges (fringed sedge, marsh straw sedge), narrow-leaved and rough-leaf goldenrod, quack-grass, strawberry (*Fragaria virginiana*), creeping buttercup, soft rush and bulrush, creeping buttercup, blackberry and wild raspberry (*Rubus* spp*)*, grasses (Kentucky blue and timothy) and possom-haw viburnum.

Animal populations at the terrestrial Project site were not specifically surveyed, apart from observations of the common occurrence of deer pellets. Old fields can support various species which move into the old field from adjacent areas, including slugs and earthworms, American toad, leopard and pickerel frogs, eastern smooth green snake, northern red-belly snakes and Maritime garter snakes (Davis and Browne 1997). Many bird species forage in old fields, but nest in adjacent woodlands. Davis and Browne note birds including bobolink, common snipe, American woodcock and northern harrier; and small mammals including common and short-tailed shrews, meadow voles and meadow jumping mice, may be present. Later successional stages with dense alder growth (which occurs at the site in question) are known to provide habitat for many species of warbler, flycatcher and sparrow and can include woodcock (Davis and Browne 1997).

Review of the NSDNR significant habitat mapping database (NSDNR 2007) did not reveal the presence of any critical habitat such as deer wintering areas in the vicinity of the Project area, it did however reveal the presence of a species at risk and a species of conservation concern in the vicinity of West Bay and the community of Black Rock. No further information was available regarding these rare or sensitive species. All of the habitats present in the study area are commonly encountered throughout the province and are unlikely to provide habitat for rare small mammal species.

3.3.3 Terrestrial Species at Risk

As noted above in section 3.2.9, Species at Risk are those plants or animals whose existence is threatened or which are in danger of being threatened, by human activities or natural events. S*ARA* is the main federal legislation protecting species at risk. Under *SARA* it is an offence to “kill, harm, harass, capture or take” any individuals of a listed species at risk, or to lead to the destruction of its nest, home, or habitat. The *Act* includes a list of species at risk and other species proposed or under consideration for inclusion, developed by COSEWIC, which is formally recognized under the *Act*.

3.3.3.1 Terrestrial Flora

Review of the NSDNR significant habitat mapping database (NSDNR 2007) revealed the presence of a species at risk and a species of conservation concern in the vicinity of West Bay and the community of Black Rock. Typically, this database does not provide the name of the species listed, however species details are provided by ACCDC (below).

From the ACCDC search requested in support of this EA, twenty-one rare or uncommon plant species have been recorded within a 10 km radius of the proposed onshore Project facilities. These are listed in Table 3-

12. Additionally, a botany report was provided by the Nova Scotia Department of Tourism, Culture and Heritage (NSDTCH), Heritage Division which listed nine additional species-at-risk that could be impacted by Project development. Table 3-13 provides a summary of rare flora for both aquatic and terrestrial habitats. The likelihood of each species being present along areas potentially affected by Project activities was assessed by comparing the habitat preferences of each recorded species against the types of habitats in the footprint of the proposed facilities. Existing habitats within the facilities footprint were derived from field observations and other data sources (*e.g.,* aerial photography).

Table 3-12 Rare and Uncommon Plant Species Recorded by ACCDC within 10 km of the Study Area

Scientific Name	Common Name	Preferred Habitat	ACCDC Rank	NSDNR Rank
Allium tricoccum	Small White Leek	Rich deciduous forests and intervales.	S1	Red
Alopecurus aequalis	Short-Awn Foxtail	Muddy margins of rivers and shallow ponds, and gravel margins where competitor species are few.	S2S3	Yellow
Amelanchier nantucketensis	Nantucket Shadbush	Pine barrens, pond margins, fields, edges, and thickets. Old fields /roadsides.	S1	Red
Arabis drummondii	Drummond Rockcress	Usually on dry slopes and talus, but occasionally in more fertile locations at lower elevations.	S2	Yellow
Asplenium trichomanes	Maidenhair Spleenwort	Damp shaded cliffs, and talus slopes. Acidic rock such as granite, basalt and sandstone.	S2	Yellow
Campanula aparinoides	Marsh Bellflower	Meadows, ditches and river banks.	S3?	Yellow
Cardamine maxima	Large Toothwort	Rich most often calcareous moist rocky slopes and deciduous woods.	S1	Red
Draba arabisans	Rock Whitlow-Grass	Muddy soils or on calcareous rocks, in cliff crevices and ledges.	S2	Yellow
Draba glabella	Rock Whitlow-Grass	Crevices in rock cliffs, ledges and talus slopes, known fom a dry sand and gravel spit in NB.	S1	Red
Dryopteris fragrans var. remotiuscula	Fragrant Fern	Dry, overhanging cliffs, and in cliff crevices along streams or near waterfalls.	S2	Yellow
Festuca subverticillata	Nodding Fescue	Rich deciduous forested slopes and alluvial woods.	S1S2	Red
Goodyera repens	Dwarf Rattlesnake-Plantain	Under conifers, growing with very few other plants.	S2S3	Yellow

Huperzia selago	Fir Clubmoss	Rock crevices on stream cliffs, and moist ravines.	S1S3	Undetermined
Juncus dudleyi	Dudley's Rush	Marshy ground.	S2?	Yellow
Lobelia spicata	Pale-Spiked Lobelia	Dry fields.	S1S2SE	Red
Malaxis brachypoda	White Adder's-Mouth	Moss cushions and wet, mossy cliff-edges, where there is little competition from other plant species.	S1	Red
Osmorhiza longistylis	Smoother Sweet-Cicely	Rich deciduous forests, intervales.	S2	Yellow
Poa glauca	White Bluegrass	Cliff crevices, on shelves, and talus slopes.	S2S3	Yellow
Rumex salicifolius var. mexicanus	Willow Dock	Beaches or along rivers.	S2	Yellow
Saxifraga paniculata ssp. neogaea	a White Mountain Saxifrage	Pockets in cliffs, mossy hillsides, dripping cliffs, and limestone ledges.	S2	Yellow
Symphyotrichum ciliolatum	Lindley's Aster	Open fields, lawns and the edges of woods.	S2S3	Yellow

S1 Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2 Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3 Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in at some locations. (21 to 100 occurrences).
S4 Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences).
S5 Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.
S#S# Numeric range rank: A range between two consecutive numeric ranks. Denotes range of uncertainty about the exact rarity of the Element (e.g., S1S2).
S? Unranked: Element is not yet ranked.
SE Exotic: An exotic established in the province (e.g., Purple Loosestrife or Coltsfoot); may be native in nearby regions.
Source: ACCDC 2008; NSDNR 2002; Roland and Zinck 1998

Table 3-13 Rare and Uncommon Plant Species Recorded by NSDTCH within the Study Area

Scientific Name	Common Name	Preferred Habitat	ACCDC Rank	NSDNR Rank
Allium tricoccum	Small White Leek	Rich deciduous forests and intervales.	S1	Red
Alopecurus aequalis	Short-Awn Foxtail	Muddy margins of rivers and shallow ponds, and gravel margins where competitor species are few.	S2S3	Yellow
Arabis drummondii	Drummond Rockcress	Usually on dry slopes and talus, but occasionally in more fertile locations at lower elevations.	S2	Yellow

Asplenium trichomanes-ramosum	Green Spleenwort	Shaded cliffs along streams, on limestone or other basic rocks.	S2	Yellow
Campanula aparinoides	Marsh Bellflower	Meadows, ditches and river banks.	S3?	Yellow
Cardamine parviflora	Small-Flower Bitter-Cress	Dry woods, shaded or exposed ledges, and in sandy soils.	S2	Yellow
Draba arabisans	Rock Whitlow-Grass	Muddy soils or on calcareous rocks, in cliff crevices and ledges.	S2	Yellow
Draba glabella	Rock Whitlow-Grass	Crevices in rock cliffs, ledges and talus slopes, known fom a dry sand and gravel spit in NB.	S1	Red
Dryopteris fragrans	Fragrant Cliff Wood-Fern	Dry, overhanging cliffs, and in cliff crevices along streams or near waterfalls.	S2	Yellow
Festuca subverticillata	Nodding Fescue	Rich deciduous forested slopes and alluvial woods.	S1S2	Red
Impatiens pallida	Pale Jewel-Weed	Rich alluvial soils, damp thickets, and along intervales.	S2	Yellow
Laportea canadensis	Wood Nettle	Alluvial woods of mixed or deciduous trees. Floodplains on the Cape Breton plateau. Only in the most fertile locations.	S3	Yellow
Poa glauca ssp. glauca	White Bluegrass	Cliff crevices, on shelves, and talus slopes.	S2S3	Yellow
Saxifraga paniculata	White Mountain Saxifrage	Luxuriant on dripping cliffs.	S2	Yellow
Sphenopholis intermedia	Slender Wedge Grass	Calcareous ledges and shores.	S3S4	Yellow
Woodsia glabella	Smooth Woodsia	Shaded vertical cliffs, and along streams in northern Cape Breton.	S2	Yellow

S1 Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2 Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3 Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in at some locations. (21 to 100 occurrences).
S4 Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences).
S5 Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.
S#S# Numeric range rank: A range between two consecutive numeric ranks. Denotes range of uncertainty about the exact rarity of the Element (e.g., S1S2).
S? Unranked: Element is not yet ranked.
SE Exotic: An exotic established in the province (e.g., Purple Loosestrife or Coltsfoot); may be native in nearby regions.
Source: ACCDC 2008; NSDNR 2002; Roland and Zinck 1998

The study site is located on Herbert Soils derived from sand and gravel in glacial outwash deposits. These soils are moderately stoney and when uncultivated, support poor quality second growth forest of red spruce, red pine and jack pine, and some birches and firs (Nowland and MacDougall 1973). Adjacent areas on Cape

Sharp are dominated by Rossway soils, cobbly glacial till of sandy loam to loam derived from basalt. These soils have a relatively high nutrient status and good quality forest stands and are known to have an elevated potential for harbouring rare plant species. It is possible that forest stands adjacent to the site could contribute species to the study site. The botanical surveys to be conducted in the spring and summer of 2009 will identify any rare species that may be present, including those that may have originated from the basalt Rossway soils.

There is some overlap between Tables 3-12 and 3-13 although there are also some differences. None of the thirty species is listed under *SARA* or the Nova Scotia *Endangered Species Act*. Seven of the species are "red" listed by NSDNR indicating that they are known to be at risk or are thought to be at risk. Twenty-two of the species are "yellow" listed indicating that they are sensitive to human activities or natural events. The status of one of the species is "undetermined" indicating that there is insufficient data to assign a population status at the current time. Undetermined species are typically those that are easily unobserved, species for which there is difficulty in distinguishing the rare species from a closely related common species or species whose taxonomy is in a state of instability.

As the Project site includes several habitats, several of the listed species are potentially present on the site, while some of the listed species prefer habitats that were not found during the field survey. For example, some of the species are typically found on exposed cliffs, a habitat absent from the Project area, although this habitat is nearby. Plants can be opportunistic and do not always follow expected patterns; however, based on habitat descriptions found in Zinck (1998), several species listed are likely to be present on the Project site. This includes the short-awn foxtail (*Alopecurus aequalis*), marsh bellflower (*Campanula aparinoides*), fir clubmoss (*Huperzia selago*), Dudley's rush (*Juncus dudleyi*), and pale-spiked lobelia (*Lobelia spicata*). The results of the habitat comparison exercise suggest that riparian habitats (including stream banks), meadows, roadsides, ditches, ravines and dry fields have the greatest potential to harbor uncommon or rare vascular plant species.

Although some of the listed species may occur on at least parts of the site based on their preferred habitat descriptions, none of the listed species of concern were identified on the site. A list of seventy-six vascular plant species was recorded, eighteen of which have no NSDNR population status, and the rest are "green" listed by NSDNR indicating that their populations in Nova Scotia are believed to be secure (Appendix 8). No rare plant species or special habitats were identified on the site. As the terrestrial portion of the Project facilities is relatively small, no specific sampling pattern was utilized.

It must be noted that the site was visited by biologists in early October, and no conclusions may be drawn as to the presence or absence of listed species more easily seen or identified in other seasons. Further terrestrial vegetation programs will be executed in 2009, including early and late vegetation surveys (June and August) timed to capture periods when potentially present species would be most easily identified, and the results provided to NSDNR. Should any listed species be determined to be present on the Project site as a result of this survey, mitigation (including avoidance where required by legislation) will be undertaken in consultation with NSDNR.

3.3.3.2 Terrestrial Fauna

From the ACCDC search, six rare or uncommon fauna species may be present within the Project area, as they have been recorded within a 10 km radius of the proposed onshore Project facilities. These species are presented in Table 3-14.

Table 3-14 Rare and Uncommon Fauna Species Recorded by ACCDC within 10 km of the Study Area

Scientific Name	Common Name	Preferred habitat	ACCDC Rank	NSDNR Rank	COSEWIC Rank
Accipiter gentilis	Northern Goshawk	Mature coniferous and mixedwood forest generally remote from human habitation.	S3B	Yellow	Not At Risk
Boloria chariclea	Arctic Fritillary	-	S2	Yellow	-
Danaus plexippus	Monarch Butterfly	-	S2B	Yellow	Special Concern
Dolichonyx oryzivorus	Bobolink	Fields with dense grass cover, particularly hay fields.	S3B	Yellow	-
Falco peregrinus anatum	American Peregrine Falcon	Almost any habitat type that provides hunting opportunities. For nesting, prefer habitats with cliffs.	S1B	Red	Special Concern
Sialia sialis	Eastern Bluebird	Open woodlands, clearings, farmlands, parks, orchards, gardens, fields, along roadsides on utility wires and fences.	S2S3B	Yellow	Not At Risk

S1 Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2 Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3 Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in at some locations. (21 to 100 occurrences).
S4 Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences).
S5 Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.
S#S# Numeric range rank: A range between two consecutive numeric ranks. Denotes range of uncertainty about the exact rarity of the Element (e.g., S1S2).
SB Breeding bird population.
SH Historical: Element occurred historically throughout its range in the province (with expectation that it may be rediscovered), perhaps having not been verified in the past 20 - 70 years (depending on the species), and suspected to be still extant.
SU Unrankable: Possibly in peril throughout its range in the province, but status uncertain; need more information.
SX Extinct/Extirpated: Element is believed to be extirpated within the province.
S? Unranked: Element is not yet ranked.
SA Accidental: Accidental or casual in the province (i.e., infrequent and far outside usual range). Includes species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range; a few of these species may even have bred on the one or two occasions they were recorded.
SE Exotic: An exotic established in the province (e.g., Purple Loosestrife or Coltsfoot); may be native in nearby regions.
SE# Exotic numeric: An exotic established in the province that has been assigned a numeric rank.
SZ Zero occurrences: Not of practical conservation concern in the province, because there are no definable occurrences, although the species is native and appears regularly. An NZ rank will generally be used for long distance migrants whose occurrences during their migrations are too irregular (in terms of repeated visitation to the same locations) or transitory. In other words, the migrant regularly passes through the province, but enduring, mappable Element Occurrences cannot be defined.

Source: ACCDC 2008; NSDNR 2002; Roland and Zinck 1998.

One of the species is "red" listed by NSDNR indicating that it is known to be at risk or are thought to be at risk. The other five species are "yellow" listed indicating that they are sensitive to human activities or natural events. However, based on research conducted as part of this study, there are only two terrestrial species at risk which occur or could potentially occur in the study area, which include the American peregrine falcon and the monarch butterfly. Other at risk species are unlikely to be present in the study area due to insufficient habitat requirements.

American Peregrine Falcon (*Falco peregrinus anatum*)

The peregrine falcon is federally listed as a species of Special Concern and listed provincially as a vulnerable species. The species is known to mainly feed on birds (*i.e.,* black guillemots and other seabirds) often caught in mid-flight and to nest on steep cliff ledges or crevices (50 to 200 m in height), along the Bay of Fundy. They have also been known to feed on bats, rodents and other mammals and sometimes nest in urban areas. Falcons migrate to warmer areas in the fall though urban residents may stay all year if food is plentiful.

Monarch Butterfly (*Danaus plexippus*)

The Monarch is a federally listed species of Special Concern. The species occurs widely distributed along the Nova Scotia East Coast in the summer and fall, often associated with the distribution of its main host plant, milkweed. Milkweed, however, were not found to occur in the botanical survey for the study.

3.4 Socio-economic and Cultural Environment

3.4.1 Population and Demographics

On-shore facilities associated with the Project will be located near the communities of Black Rock, West Bay and Parrsboro, Cumberland County, Nova Scotia. Little information is available regarding the communities of Black Rock and West Bay, both of which are described as small communities on the shore of the Bay of Fundy. Black Rock has a number of permanent residents, many of whom fish the bay for a living, as well as a number of vacation cabins. West Bay however, is considered a part of the community of Parrsboro, as the road from Parrsboro to West Bay is a dead end. Due to the limited information available regarding the immediate Project area, for the purposes of this Project, description of the socio-economic conditions will be in the context of the broader regional area, namely the Bay of Fundy, the Town of Parrsboro and surrounding Cumberland County.

Prior to the arrival of Europeans, Parrsboro was a portage point for Mi'kmaq travelers navigating through the Cumberland County river systems. The first European settlers in the area were the Acadians, who were later expelled by settlers from New England in the mid-to-late 1700's. One settlement eventually grew and was given the name the Township of Parrsboro in 1784, after Governor John Parr. The Town of Parrsboro was later incorporated in 1889 (Parrsboro Economic Development Committee 2008).

Relevant population and demographic information for both the Town of Parrsboro and for Cumberland County published by Statistics Canada (2006) are summarized below in Table 3-15.

Table 3-15 Population and Demographic Information for the Town of Parrsboro and Cumberland County, Nova Scotia

Population/Dwelling Count	Town of Parrsboro	Cumberland County
Land Area (per km^2)	14.88	4,271.14
Population Density (per km^2)	94.1	7.5
2006 Population	1,401	32,046
2001 Population	1,529	32,605
Population Change Between 2001 and 2006 (%)	-9.1	-1.7
Total Number of Private Dwellings	835	18,153

Between 2001 and 2006, the Town of Parrsboro experienced a population decrease of approximately 9.1%, in addition to the previous decrease between 1996 and 2001 of approximately 5.8%. Generally, the population in 2006 was evenly distributed across all age groups; the exception being the age ranges 5 - 19 and 40 – 54, which are slightly more numerous and which may represent parent and child groups. The median age of the population in Parrsboro is 48 years, slightly higher than the provincial median of 41.8 years, and the percentage of the population over the age of 65 is approximately 25%, which is again higher than the provincial average of approximately 15%. As of 2006, less than 1% of the population identified themselves as Aboriginal, while closer to 6% identified as immigrants (Statistics Canada 2006).

Similarly, Cumberland County experienced a population decrease of approximately 1.7% between 2001 and 2006. A much more substantial decrease was experienced in the county between 1996 and 2001, where the population decreased by approximately 5%. The population distribution in Cumberland County is similar to the Town of Parrsboro, fairly even across age groups and with the same spikes for the age ranges 5 - 19 and 40 - 54. The median age of the population is 45.4 years, again slightly higher than the provincial median. Again, less than 1% of the population in Cumberland County identified themselves as Aboriginal, while approximately 3% identified as immigrants (Statistics Canada 2006).

3.4.2 Industry, Employment and Health Services

The Town of Parrsboro, similar to many other maritime communities, has suffered economically as a result of the collapse of a number of important industries, especially the decline of wooden shipbuilding, the depletion of local forests, and the closing of the Springhill coal mines which ended coal shipments from the area. Additionally, the Trans-Canada Highway which once ran through the center of Parrsboro was relocated to the Wentworth Valley in the 1960s. A number of small business in the area have remained over the years, including a number of fishers, mills, blueberry operations and Parrsboro Metal Fabricators, a firm which been produces home heating oil tanks for the region. Additionally, there are many seasonal accommodations, restaurants and attractions in the town due to the local tourism industry.

In Parrsboro, approximately 12% of the total labour force is concentrated in the manufacturing and construction industry, 11% in agriculture and other resource-based industries, and 46% in the service industry. In Cumberland County, approximately 22% of the total labour force is concentrated in the manufacturing and construction industry, 10% in agriculture and other resource-based industries, and 32% in the service industry. Overall, more than half of the total labour force in both the Town of Parrsboro and in Cumberland County is employed in manufacturing, construction, and service industries. Other industries employing people in the Town of Parrsboro and Cumberland County include real estate and finance, retail and wholesale trades, education and health services. Table 3-16 displays the proportion of the total experienced labour force employed in each major sector for the Town of Parrsboro and Cumberland County.

Table 3-16 Industry Participation for the Town of Parrsboro and Cumberland County

Industry	Town of Parrsboro			Cumberland County		
	Total	Male	Female	Total	Male	Female
Total Experienced Labour Force	525	280	245	14,880	7,655	7,230
Resource-Based Industry (Including Agriculture)	55	45	10	1,445	1,175	275
Construction and Manufacturing Industry	65	55	10	3,210	2,290	925
Retail and Wholesale Trade	50	25	25	2,490	1,165	1,320
Real Estate and Financial Service	20	0	20	465	160	300
Education and Health Service	90	10	80	2,545	475	2,065
Business Service	75	50	25	1,740	1,045	695
Other Service	165	85	80	2,990	1,345	1,645

According to the 2006 census reporting Cumberland County data from 2005, 16,600 individuals earned an income as a result of full or par time work. The median earning was $17,838, which is below the provincial median earning of $22,608 for the same year. Those individuals who had full-time work earning of $36,917. Similarly, median earnings for those individuals in Parrsboro who had full-time work year round were $30,671, below the provincial median. In the Town of Parrsboro, unemployment rates are approximately 10%, while in Cumberland County the rate is just above 11%, both of which are higher than the provincial unemployment rate of 9% (Statistics Canada 2006).

3.4.3 Property Values

According to the 2006 census, there were 660 total private dwellings in the Town of Parrsboro; 490 owned and 175 rented. The majority of these dwellings were constructed prior to 1986 and the average value of such a dwelling (owned) was $116, 439, nearly $42,000 less than the provincial average. Generally, the value of an owned dwelling in Cumberland County is $100,041, which is again much lower than the provincial average of $158,000 (Statistics Canada 2006).

3.4.4 Recreation and Tourism

For both the provinces of Nova Scotia and New Brunswick, the Bay of Fundy and its coastline attract tourists and recreational users to enjoy the spectacular scenery, wildlife, cultural assets and range of recreational opportunities. Tourism in this area is promoted jointly by both provincial governments and the Bay of Fundy Tourism Partnership. The Partnership includes Fundy-based businesses, regional and provincial tourism organizations, and development agencies from both provinces (Jacques Whitford *et al.* 2008).

As with much of rural Nova Scotia, one of the primary industries in the area is tourism. Nova Scotia markets itself as a natural, coastal destination, and the Bay of Fundy is a key tourism icon for Nova Scotia. The focus for tourism development is around the development of sustainable products that highlight those elements. From a tourism perspective, the Bay of Fundy area primarily provides scenic touring experience that focuses on the coastal viewing/access. The area has an extensive history and natural beauty, giving it tourism appeal and potential. While tourism-related services are a principal source of revenue for the town, agricultural employment is also significant from surrounding mixed farms and blueberry harvesting (Government of Canada 2007). Parrsboro is a favorite area for nature lovers, with many hiking trails, camp sites, eco-tour look off locations, beaches and public parks, including the Cape Chignecto Provincial Park (45 km west of Parrsboro) and the Five Islands Provincial Park (32 km east of Parrsboro) (NSDNR 2008).

On the opposite side of the Minas Passage, there are two additional recreational and tourist-related parks; Cape Blomidon Provincial Park and Cape Spilt. Renowned for spectacular natural beauty, Blomidon Provincial Park is located approximately 20 km from Wolfville. The Cape Split property is located at the end of the Blomidon peninsula and was privately owned since the 1920s until the Nova Scotia government acquired 280 hectares in 2002. Cape Split is recognized provincially and nationally by visitors to the area for its cliff formations, colonies of sea birds, rare vegetation, scenic views and dramatic tides.

The Bay of Fundy coastline around Parrsboro has abundant cliffs that contain fossils of prehistoric animals and plants. Two museums in Parrsboro are dedicated to geological history; the Fundy Geological Museum, and the Parrsboro Rock and Mineral Shop and Museum. Another museum in Parrsboro is the Ottawa House built in 1775, which occupies the original town site and is near the legendary landing site of Henry Sinclair. In addition, Parrsboro is home to the Ship's Company Theatre, a professional company performing at their new theatre facility built around the last of the Minas Basin ferries.

The Parrsboro area offers many recreational opportunities; including the Parrsboro Golf Club, ice skating and hockey rink, soccer and baseball fields, tennis and basketball courts, fresh and saltwater fishing and swimming, canoeing, kayaking. Additionally, there are a number of hiking trails, ATV or snowmobile access roads and look-offs with opportunities for bird watching (Parrsboro Economic Development Committee 2008).

As noted through correspondence with Terri McCulloch of the Bay of Fundy Tourism Partnership, there are currently no marine operators of tour boats or kayaks based in Parrsboro Harbour who have point-of-sale kiosks or storefronts. There is one boat operator, The Tide Chaser, which provides boat tours; however, these tours are arranged through word of mouth only and occur on an irregular schedule. Similarly, local fishermen may also occasionally take people out but only after the summer lobster season ends on July 31. (McCulloch pers. comm. 2009).

There are a number of kayak companies including NovaShores Adventures kayaking – primarily off Cape Chignecto Eatonville/ Advocate Harbour, Freewheeling Adventures and Coastal Adventures out of Halifax, and FreshAir Adventures out of New Brunswick, who operate tours nearby. In general, the Minas Passage is too turbulent to attract them up shore to Parrsboro (McCulloch pers. comm. 2009). Communications with Mr. Werner Ostermann of NovaShores Adventures confirmed that the area of the Demonstration Facility, including the beach associated with the on-shore facility is not used for kayaking/ ecotourism. In general, NovaShores Adventures operate around Cape Chignecto Provincial Park or the Advocate Harbour/ Cape d'Or area for approximately 6 months per year (May to October) (NovaShores Adventures pers. comm. 2009).

There is currently no commercial sailing or jet skiing anywhere along the shore from Truro around to the Joggins Fossil Cliffs, although many of the locals enjoy this type of recreation. The tide schedule, of course, is also a challenge to smooth business operation of an outdoor adventure company (McCulloch pers. comm. 2009).

Detailed recreational fisheries catch within the Bay of Fundy is not available by geographic locations. Most recreational catch is reported at the county level. Sporadic recreational fishing for groundfish occurs within Minas Basin and Minas Channel, but it is not likely to occur near proposed Demonstration Facilities because of the high currents in the area.

3.4.5 Land and Marine Resource Use

Land and marine resource use within the Project area is primarily comprised of fisheries, as well as recreation and tourism activities (discussed previously in Section 3.4.4). Fisheries of the Bay of Fundy (DFO Unit Areas 4XR and S – Figure 3-14) were described in the SEA report for Bay of Fundy Tidal Power (Jacques Whitford *et al.* 2008). Additional detail regarding commercial fisheries is given in Appendix 9 (CEF Consultants Inc. 2008; 2009).

The Bay of Fundy supports a vibrant commercial fishery that is important to coastal communities around the Bay. The largest commercial fin fisheries are located in the Outer Bay and exploit fish that use the Bay as a feeding ground during summer or concentrate in the region for spawning. Groundfish, including dogfish, and herring are fished throughout the Bay, including within Minas Basin. Lobster is an important commercial species in all areas. The Inner Bay (including the Minas Passage/Channel) supports smaller commercial fisheries which tend to be fished from nearby communities (discussed in Section 3.4.5.2), except for herring, which are fished throughout the Bay by both large seiners from ports outside the inner bay or by shore-based weirs and gillnets throughout the western shore (New Brunswick) and inner bays. Inner bay fisheries comprise primarily lobster, herring and soft-shell clams; however, many species in the Outer Bay also move in and out of the Inner Bays, and the Inner Bays may be an important nursery area for many species. As such, both the Inner Bay, as well as the larger Bay of Fundy will be discussed in the sections below.

3.4.5.1 Regional Use – Bay of Fundy

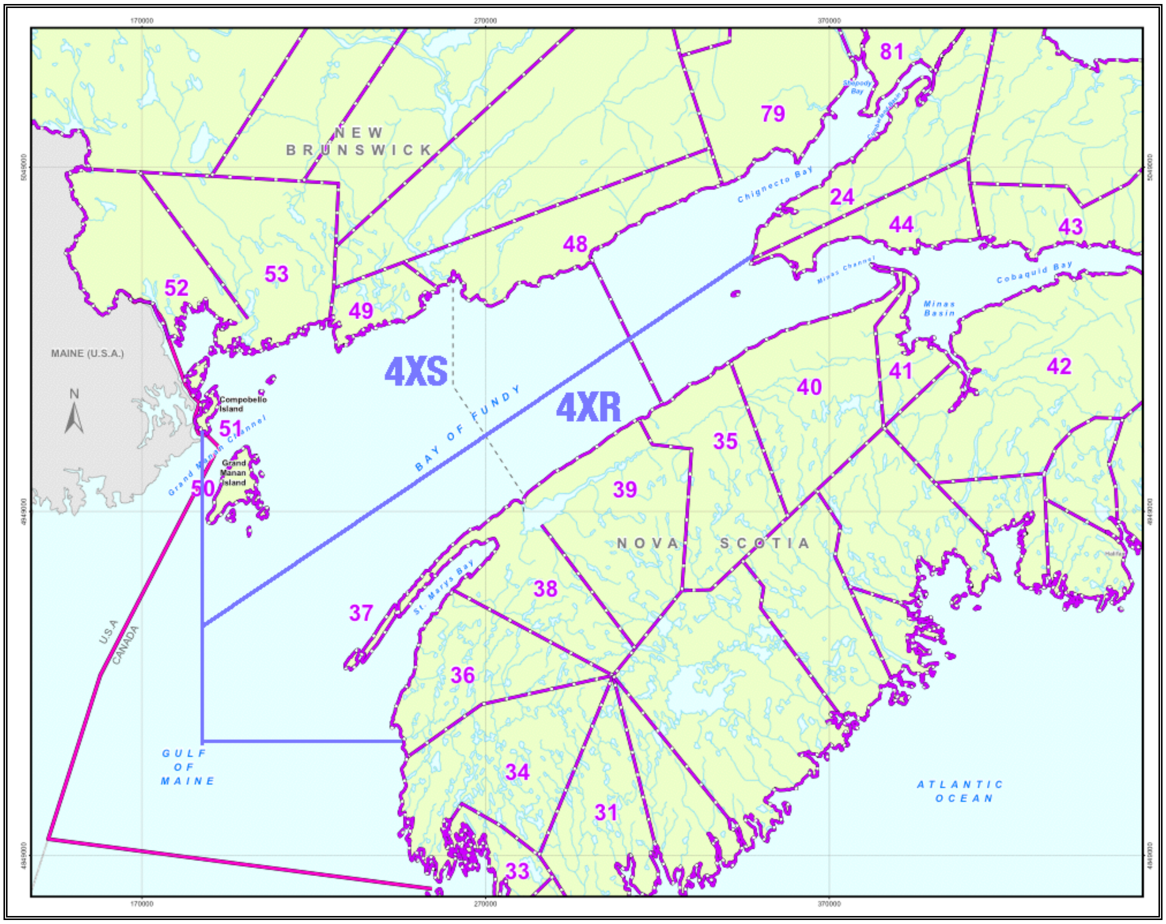
Most fisheries within the Bay of Fundy have long traditions, but some fisheries, such as those for dogfish, sea urchin, marine worms and some seaweeds are relatively recent. Experimental fisheries for sea cucumber have also been carried out in the outer western part of the Bay (DFO Unit Area 4XS). Some catch of large pelagics, such as tuna and swordfish, and certain sharks, such as mako and porbeagle, occur in outer parts of the Bay.

Groundfish

Approximately fourteen fish species constitute the ground or demersal fish community of the Bay of Fundy that are fished commercially. Groundfish tend to occur in the Bay during summer while migrating to and from the Scotian Shelf where spawning takes place (Mahone *et al*. 1984; MacDonald *et al*. 1984). Cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and pollock (*Pollachius virens*) are caught in both trawl and longline fisheries, whereas flounders, including Atlantic halibut (*Hippoglossus hippoglossus*), American plaice

(*Hippoglossoides platessoides*), witch flounder (*Glyptocephalus cynoglossus*) and winter flounder (*Pseudopleuronectes americanus*), are caught primarily in the trawl fishery. Cod may spawn on the western side of the Outer Bay (Hunt and Neilson 1993), but more recent studies suggest that traditional spawning areas for cod, haddock and pollock in the Bay of Fundy may be no longer used (Buzetta *et al.* 2003).

FIGURE 3-14 FISHERIES MANAGEMENT BOUNDARIES FOR THE BAY OF FUNDY



Source: Adapted from Jacques Whitford *et al.* 2008

Pollock are the most abundant semi-pelagic gadoids in the Bay. In 2007, just less than 141 tonnes were caught in the eastern Bay and Minas Basin (Unit Area 4XR) by trawlers and longliners combined.

Winter flounder are the most important commercial and recreational flatfish in the Bay of Fundy, with approximately 413 tonnes caught by trawler over 2007 within Unit Area 4XR.

Atlantic halibut (*Hippoglossus hippoglossus*) is one of the most valuable groundfish and small landings of halibut are made in Statistical Districts 35, 40 and 44 along the Nova Scotia shore of the Inner Bay (Dyer *et al.* 2005). Just more than 44 tonnes of halibut were caught in Unit Area 4XR over 2007.

Two species of hake are common in the Bay of Fundy; the white hake (*Urophycis tenuis*) and the silver hake (*Merluccius bilinearis*). Both are found in the Bay of Fundy, but only the white hake is captured to any extent and then only as by-catch in the groundfish fishery.

Wolfish have never constituted a large portion of Canadian groundfish landings, but they are caught in the Bay of Fundy. The three species of wolfish (*Anarhichas* sp.) are considered species of concern and no direct fishery occurs.

Monkfish (*Lophius americanus*) have become a relatively valuable commercial species in recent years, caught predominately by trawlers, as well as a fishery for springy dogfish, which began in 1987 and expanded during the 1990s (Percy *et al.* 1997).

Spiny dogfish (*Squalus acanthias*) have at times formed a large component of the commercial finfish catch within the Minas Basin. Dogfish are common both on the bottom and in the water column. Landings of dogfish in Minas Basin (Statistical District 40) were approximately 700 MT in both 2001 and 2002 (Dyer *et al*. 2005). Dogfish are currently fished primarily by longliner and form the largest component of the catch for that gear. Since females are larger and more desired, the fishery is frequently carried out in the Upper Bay (Jacques Whitford *et al.* 2008).

Pelagic Fishes

Herring (*Clupea harengus*) have traditionally been the dominant pelagic species fished commercially in the Bay of Fundy, fished by large seiners and shoreline weirs. Minas Basin herring are a unique population within the Bay of Fundy. The weir fishery is concentrated in the Outer Bay where sardine-size herring have been captured, canned and exported from Blacks Harbour for the last 120 years (Jacques Whitford *et al.* 2008). The weir fishery in the Inner Bay lands sizeable catches but these are intermittent and seasonal – in 2007 only 7 tonnes were reported caught in weirs in Unit Area 4XR, which includes Minas Basin. The herring weir nearest to the Project area is located at Partridge Island, approximately 8 km east of the Demonstration Facility. Gillnet fisheries are concentrated along the Nova Scotia shore in the Outer Bay and in Minas Basin (Dyer *et al.* 2005), but catches are low compared to the mobile, purse seine fishery which lands the majority (about 98%) of the annual catches.

Until recently, Porbeagle shark (*Lamna nasus*) were exploited by a directed gillnet fishery in the Outer Bay of Fundy (Campana *et al*. 2002), however, the fishery is now closed because Porbeagle was listed as Endangered by COSEWIC (COSEWIC 2005).

Bluefin tuna (*Thunnus thynnus*) and swordfish (*Xiphias gladius*) are landed in the Bay of Fundy ports but very little of these catches come from the Bay of Fundy. Tuna have become a highly valued catch since shipments to Japan began during the 1980s (Percy *et al*. 1997). There is a fishery for tuna on the Scotian Shelf and many of these are landed in Yarmouth (Statistical District 34). Swordfish are only captured around the edges of the Scotian Shelf mostly over great depth (Scott and Scott 1988) and some of these are landed in Fundy ports.

Diadromous Fishes

Apart from gaspereau, diadromous species are primarily fished recreationally; however, there are a number of exceptions, including the Inner Bay of Fundy Atlantic Salmon (*Salmo salar*) which was once the premier commercial and recreational fish of the Bay of Fundy. The commercial fishery for salmon was closed permanently in 1984 and in 2001 the Inner Bay of Fundy stocks were declared Endangered by COSEWC (DFO 2004). Atlantic salmon aquaculture in the outer Bay of Fundy, however, provides a major industrial base to areas such as Grand Manan Island.

Sturgeons (*Acipenser* sp.) are primarily sought as a source of caviar. They are captured in drags and intertidal weirs in the Bay of Fundy and by gillnet in the rivers and estuaries (Leim and Scott 1966). Annual catches in Minas Basin can amount to 100 sturgeons a year in some weirs and daily trawler catches may reach 20-30 individuals (Jacques Whitford *et al.* 2008). Since 2002 DFO has prohibited the take of sturgeon in the Maritimes in coastal weirs and as by-catch in the trawler fishery.

Americal eel (*Anguilla rostrata*) are fished commercially, but landings are low and may be inaccurate. A small recreational fishery with a daily bag limit of 10 exists in some areas.

American shad (*Alosa sapodissma*) are abundant in the Bay of Fundy. They are caught both commercially and recreationally in estuaries and rivers during their migration upstream in spring to spawn. Shad are caught in weirs, traps, gillnets, scoop nets and by rod and line. The largest commercial fishery in the Nova Scotia waters of the Bay of Fundy is in the Shubenacadie River (Dyer *et al.* 2005). Recreational fisheries are primarily on the Annapolis and Shubenacadie Rivers (Jacques Whitford *et al.* 2008).

Minas Basin has been the location of commercial shad fisheries for three centuries (Dadswell *et al.* 1984). The fishery was pursued with intertidal weirs, fixed gillnets and drift gill nets. After 1990, however, restrictive management to protect the endangered Inner Bay of Fundy Atlantic Salmon were a factor in lower catches. The fixed and drift gillnet fisheries have been restricted by season length and many licenses were bought back because of the by-catch of Inner Bay of Fundy Atlantic Salmon in that particular fishery. The weir fishery has been forced to decrease weir height.

The gaspereau fishery exploits two species of river herring; the alewife (*Alosa pseudoharengus*) and the blueback herring (*Alosa aestivalis*). The gaspereau resource is exploited in freshwater using trap nets, scoop nets, gill nets and by angling. The major commercial fisheries around the Bay of Fundy are in the Saint John, the Shubenacadie, the Gaspereau, and rivers along southwest Nova Scotia around Yarmouth. The Black River system is the closest to the proposed tidal site and there are 18 fishermen with commercial gaspereau licenses on this river; 16 square net licenses, 1 set gillnet license, and 1 drift net license. Between about 200,000 and 400,000 fish were taken in the commercial fishery annually between 2002 and 2006. The fishing season begins on March 15th and closes May 30th (McIntyre *et al*. 2007). There are also small recreational fisheries in many Bay of Fundy Rivers. Most angled gaspereau are taken by jigging. The daily bag limit was set at 20 in 2002 and the season is from March to May.

Rainbow smelt (*Osmerus mordax*) are abundant throughout the Bay of Fundy. Bay of Fundy rainbow smelt are harvested recreationally during their spawning runs by dip netting and angling (Percy *et al.* 1997).

Striped bass (*Morone saxatilis*) are found throughout the Bay of Fundy but are most common in Minas Basin, various estuaries (Saint John, Annapolis, and Shubenacadie) (Leim and Scott 1966).

The Shubenacadie/Stewiacke Rivers support the only current, sizeable, local spawning population of striped bass. Sport fishery data suggest that a decline in striped bass abundance occurred in the Shubenacadie River between 1950 and 1975; but that the numbers subsequently remained relatively stable (Jessop 1991). Angling for striped bass in the Bay of Fundy is concentrated in the Saint John estuary, Minas Basin and tributaries, Annapolis Basin and tributaries and estuaries around Yarmouth (Leim and Scott 1966; Dyer *et. al*. 2005). Anglers may take only one fish/day and it must be larger than 62.5 cm.

Invertebrate Fisheries

Fifteen species of invertebrates contribute to Bay of Fundy fisheries. In recent years, invertebrate fisheries have surpassed finfish in landed value. Unlike many of the commercial fish species, the invertebrate fisheries are mostly based on populations that reside and reproduce in the Bay of Fundy.

American lobster (*Homarus americanus*) is fished commercially in all parts of the Bay of Fundy except the extremely turbid waters of Cobequid Bay and inner Cumberland Basin, and is caught using baited traps. Most of the Bay of Fundy is limited to a season from late November to July with some winter restriction. In

Minas Basin (LFA 35), the season is open from October 14 to December 31 and again from the last day of February to July 31 (Variation Order 2005-115).

Jonah (*Cancer borealis*) and rock crabs (*Cancer irroratus*) occur over rocky/ gravel bottom substrates along with American lobster. Jonah and rock crabs have been landed as a by-catch of the lobster fishery since the 1960s but were never developed as a directed fishery because of processing difficulties (Robichaud and Frail 2006). During the 1990s, because of the large scale development of red and snow crab fisheries, processing capacity became available. The directed Jonah and rock crab fisheries were developed as exploratory fisheries in the Bay of Fundy region starting in 1995 (Robichaud and Lawton 1996). After 10 years as an exploratory fishery sufficient commercial resources were found and the fishery was declared commercial in 2004.

The fishery for Jonah crab is located in 50 - 300 m depths south of Grand Manan and on the Middle Ground off Yarmouth (Robichaud and Frail 2006). Rock crab is mainly caught in St. Mary's Bay, Annapolis Basin and Passamaquoddy Bay in depths less than 50 m. Both fisheries are managed with license limits (4 - 10 in each lobster fishing district), trap limits (100 - 300), seasons (outside the lobster fishing season), and size limits (Jonah crab, 130 mm carapace width; rock crab, 102 mm carapace width). The fisheries are concentrated almost exclusively on males. Crabs are landed almost exclusively in the Outer Bay of Fundy in Statistical Districts 37 and 38.

Sea scallops (*Placopecten magellanicus*) are fished commercially in all regions of the Bay of Fundy except the extremely turbid Cobequid Bay and Cumberland Basin (JW 2008). The largest commercial fishery occurs immediately off Digby with lesser beds in Scott's Bay, around Ile Haute and off Lurcher Shoal. Catch from the scallop dragger fleet from Unit Area 4XR was approximately 2243 tonnes in 2007, with approximately 1.6 tonnes of monkfish also caught by drags. The scallop fishery in the Bay of Fundy involves 3 fleets: the All-Bay fleet, the Upper-Bay fleet and the Mid-Bay fleet. The All-Bay fleet has access to the entire Bay, the Upper-Bay fleet may not fish seaward of a line from across the Bay through Ile Haute and the Mid-Bay fleet may not fish south of a mid-Bay line running down the Bay from Advocate Head. The Bay of Fundy is divided into Scallop Production Areas (SPAs) and each Area has a quota that is divided among the various fleets, with the Upper Bay fleet having a Total Allowable Catch (TAC) of 80 tonnes (Smith *et al.* 2008).

There is also a recreational, scuba diving fishery for scallop in the Bay of Fundy. The fishery is restricted by season possession limit and minimum size, but there are no statistics on the annual landings from this fishery.

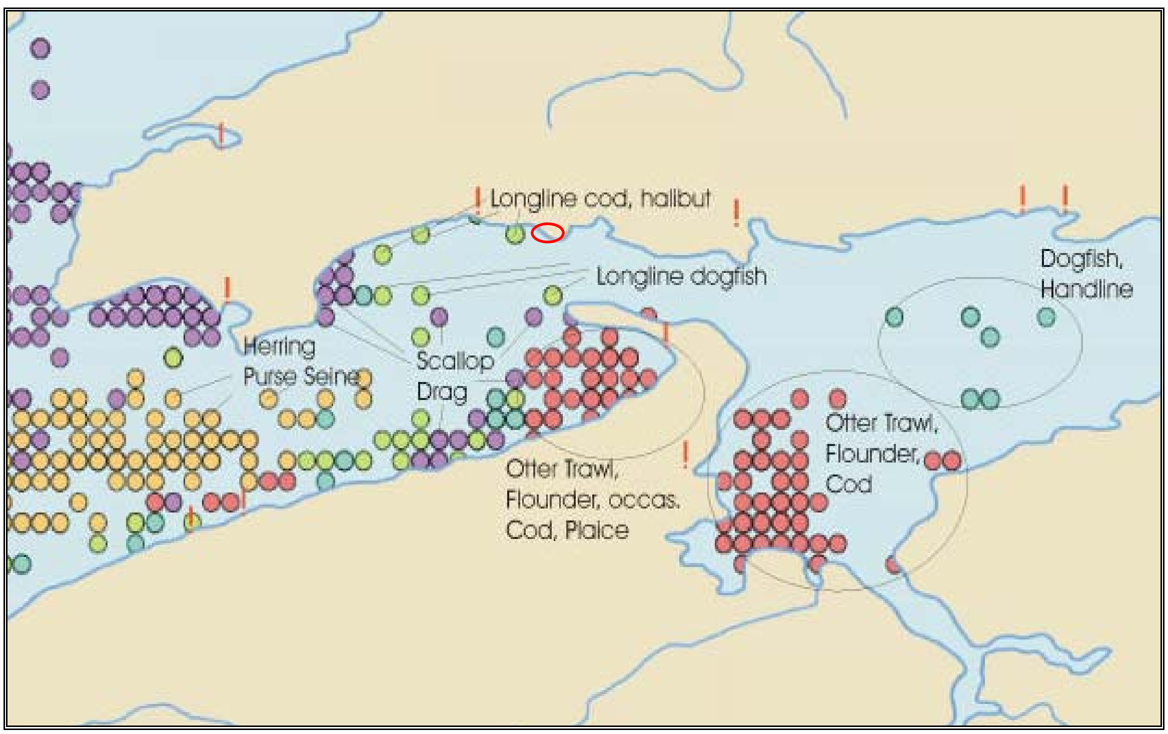
Soft-shell clam (*Mya arenaria*) is abundant in the soft sediment intertidal flats of mud, sand, or gravel in the inner Bay of Fundy. Clams are harvested commercially and recreationally by digging the intertidal flats with a shovel or clam hack (rake). Licensed commercial diggers average 25 - 50 km per tidal cycle. Recreational fishers are restricted to 100 clams/day (DFO 1996). There are four regions in the Bay of Fundy that support commercial clam fisheries: Charlotte County in southwestern New Brunswick; the north shore of Minas Basin; Annapolis Basin; and around Yarmouth Nova Scotia. Commercial landings have been monitored for more than 100 years and exhibit cyclic peaks which are related to both environmental and social factors, but overall landings have been declining since 1950 (Robinson 1995). The clam fishery in Statistical District 43 along the northern shore of Minas Basin mirrors these long-term changes (Dryer *et al.* 2005), and between 2004 and 2007 clam landings ranges from 18 to 76 tonnes.

In addition, there are a number of lesser known fisheries occurring in the Bay of Fundy including:

- The periwinkle (*Littorina littorea*) fishery, which concentrated in the lower Bay of Fundy;

- Two species of squid, the short-fin squid (*Illex illecebrosus*) and the long-fin squid (*Loligo pealei*); these species have been relatively scarce in recent years;
- Sea urchin (*Strongylocentrotus droebachiensis*) which extends from Digby County into the Minas Channel;
- The orange-foot sea cucumber (*Cucumaria frondosa*) is fished in an exploratory manner only in the Outer Bay;
- Three species of marine worms are harvested in the Bay of Fundy, which burrow into the intertidal mud and sand flats and include: bloodworm (*Glycera dibranchiate*), sandworm (*Nereis virens*), and clamworm (*Nereis* sp.);
- Seaweeds, including dulse, Irish moss and rockweed, are harvested primarily in the outer bay; and
- Figure 3-15 summarizes the fishing activity in the area of interest, with the exception of lobster and other shellfish. The key point of interest is the very limited fisheries activity in the proposed Project area (red oval).

FIGURE 3-15 LOCATION OF REPORTED CATCH FOR LANDED FISH, EXCLUDING LOBSTER AND OTHER SHELLFISH, IN 2003.



(Modified from Dyer et al. (2005)). Colour of dots indicates gear type.

<u>*Fishing Communities*</u>

Within the coastal communities along the Bay of Fundy, including Statistical Districts 37 to 53, fishermen make up approximately 7% of the population (Raymond 1986). The proportion is somewhat lower within communities bordering Minas Basin, at about 5% (excluding Parrsboro). The proportion of the population working in primary industry, which includes fishing, is highly variable and is not highly correlated with location or size of community. The relative prosperity (based on family income) among these communities is also highly variable and not well correlated to location or population size. Family income within the coastal communities around Minas Basin tends to be lower than the provincial average, but fall within the range of other coastal communities around the Bay of Fundy. The largest concentration of landed value occurs in the Digby and Digby Neck area.

Statistical Districts 41 to 44 cover Minas Basin, with District 44 extending as far as Cape Chignecto and including Parrsboro and Advocate Harbour. The landed value in the Statistical Districts entirely within Minas Basin (41 to 43) are considerable lower than most other Bay of Fundy districts, but similar to those within Chignecto Bay (Raymond 1986). Two factors contribute to this difference in landed value. One is that the inner portions of both Minas Basin and Chignecto Bay tend to have a different species assemblage. Dadswell *et al.* (1984) reported that the inner portions of Minas Basin and Cobequid Bay have lower salinities and the fauna reflect an estuarine-mudflat group of juvenile and adult tomcod, smelt, silversides and smooth flounder. Fauna in the other reaches reflect an oceanic-sand beach group of juvenile herring, white hake, winter flounder and adult and juvenile three-spine sticklebacks. The other difference is the extreme tidal range in the inner bay that makes it more difficult to moor fishing vessels.

Landings in the Bay of Fundy reflect the general distribution of fish within the Bay of Fundy for most shellfish species, but not necessarily for finfish, particularly herring. Ground fish tend to be landed on the Nova Scotia side of the Bay, while herring are landed on the New Brunswick side. Major groundfish landings occur as far into the Bay as District 40, in ports like Halls Harbour and Scots Bay.

Within Minas Basin (Statistical Districts 41 to 44) landings of groundfish are concentrated in Statistical District 41. A comparison of landings from 2004 to 2007 (DFO Statistical Tables 30 and 31) indicate a similar catch composition, with the addition of large numbers of dogfish in 2004 to the total groundfish catch in Districts 41 (73 tonnes) and 42 (153 tonnes). Catch of gaspereau, generally a commercial species in the Gaspereau and Shubenacadie Rivers, was not specified by species in landings reports, but is assumed to have been a major portion of the unidentified species reported within Districts 41 and 42 in 2004 to 2006, but absent in 2007. Catch of shellfish, including lobster, soft-shelled clam and scallop, were relatively consistent within the Statistical Districts of Minas Basin from 2004 to 2007.

3.4.5.2 Local Use – Demonstration Facility and Onshore Facility

Available information suggests that Minas Channel, and specifically the area of the proposed Demonstration Facility, is an area of high tidal flow where little commercial fishing takes place (Figure 3-15). It is also a migration route used by fish, including shellfish, in their seasonal movement in and out of Minas Basin to feed or reproduce. The primary staging area prior to entry into Minas Basin through the channel appears to be south of Cape Split near Scots Bay.

Within Minas Basin, the economic role of commercial fisheries in local communities is comparatively smaller than in the Outer Bay, but no less important at the level of the individual fisherman. With the exception of lobster, other commercial fisheries in the general vicinity of the project are peripheral to and are generally less intensive in the Minas Passage area. Information gathered to date indicates that scallop, dogfish, halibut and herring fisheries are non-existent in the proposed Demonstration Facility site; the closest fishing activity (excluding lobster) is a herring weir located at Partridge Island, approximately 8 km east of the proposed Facility.

The most important commercial fishery is the lobster fishery. Eleven lobster boats routinely fish in the Minas Channel/Passage area (part of LFA 35). Lobsters are fished with baited traps using small to medium sized vessels (10 - 20 m in length) because much of the fishery is in relatively shallow water (<20 m). Fresh or frozen fish, frequently mackerel or gaspereau, is generally used as bait and much of this is caught locally. Regulatory controls include a limit on trap number/ fisher (usually around 300 - 375), size of trap opening, minimum size limits (carapace length), and seasons. Most of the Bay of Fundy is limited to a season from late November to July with some winter restrictions.

Landings increased during the 1980s and continued to increase during the 1990s (Dryer *et al.* 2005). Landings from the Nova Scotia shore of the Outer Bay of Fundy, which produces approximately 90% of the catch, increased 36% between 1990 and 2006 and landings along the New Brunswick shore of the Bay increased by 300%. Reported lobster landings from Minas Basin Statistical Districts 41 to 44 doubled from 110 tonnes in 2004 to approximately 220 tonnes in 2007 and 2007. Prospects look promising for continued good recruitment to the fishery (Robichaud and Pezzack 2007).

Most fishing takes place along the Blomidon, Scots Bay and Parrsboro shores, and is concentrated nearshore although traps are occasionally set in deeper, high current areas (Appendix 9; CEF Consultants Inc. 2008; 2009). The present understanding is that there is lobster fishing near and around the proposed demonstration facility site, with between 3-4 boats that fish in that area and nearshore in the vicinity of Black Rock. However, the exact number of lobster fisheries is difficult to confirm and may vary year to year.

One of the main issues raised by lobster fishers is the size of the exclusion zone around the turbines, and the cable route to shore. A 300 m radius exclusion area for fishing around each turbine has been proposed and presented to fishers, however, requires additional discussion. This proposed exclusion area was intended to address lobster fishing, in other words no traps would be set within 300 m of the devices. Depending on the requirements for turbine and cable maintenance and safety issues, and specific regulatory requirements for clearances, there is anticipated loss of fishing access extending 300m from the turbines. The final size of the exclusion area will require further consultation with area fishers. Notification near shore will be required where the cable comes ashore to prevent anchorages and the placement of lobster traps in the vicinity of the cable.

There are no aquaculture operations in the Minas Passage area and there is no expected future development in this area due to the high currents and tidal range.

The on-shore facility proposed for a potion of Lot 84-PM (PID 25347451) which has a total area of approximately 2 ha (20,000 m^2) and is owned by L. Pelletier. Currently this lot is used for residential purposes. A lease will be obtained from the landowner in order to allow for development of the electrical facility on these lands. Based on discussions with officials of the Municipality of the County of Cumberland, the lot is currently zoned G (general) and so no change in zoning is expected to permit the proposed use for an electrical facility.

3.4.6 Aboriginal Peoples' Communities

Historically the Mi'kmaq people called the Parrsboro area "Awokum" (a crossing over point), as it offered the narrowest crossing of the Minas Basin (the inner southern arm of the Bay of Fundy). The area has many Mi'kmaq creation legends of Glooscap who is also believed to have brought the Mi'kmaq stoneware, gemstones, knowledge of good and evil, fire, tobacco, the Fundy tides, fishing nets and canoes. There is a twelve foot sculpture commemorating Glooscap outside the Parrsboro Town Hall (Government of Canada 2007).

There are no First Nations reserves in or immediately surrounding the Project areas on the Cumberland County side of the Minas Passage. Millbrook First Nation located on the outskirts of Truro, Nova Scotia is the nearest reserve lands to the Project by land. Across the Minas Channel, there are two reserve lands, Annapolis Valley First Nation at Cambridge, NS and Glooscap First Nation in Hantsport, NS. As well, the Fort Folly First Nation in Dorchester, New Brunswick operates commercial fishing vessels from Parrsboro Harbour.

Within Nova Scotia and New Brunswick, 17 First Nations communities have access to commercial fisheries in the Bay of Fundy and its approaches. In addition to the First Nations who are adjacent to the Bay of Fundy, bands from Cape Breton Island and northwestern New Brunswick have fishery access in the Bay. All five First Nation communities in Cape Breton have fishing access to scallops and/or groundfish. A number of inland New Brunswick First Nations have been provided with commercial fishery access to Grand Manan Island or from mainland ports on the Bay of Fundy (TriNav Fisheries Consultants 2007). In addition to First Nations, natives not considered to belong to First Nation bands have commercial fishing licences in a number of areas.

Three First Nation Bands fish in the upper Bay of Fundy. The Annapolis Valley First Nation fish two LFA 35 lobster licences based out of Digby and Harbourville and a scallop licence out of Digby. The Millbrook First Nation fish four LFA 35 lobster licences from Digby and one from Joggins, as well as two scallop licences out of Digby. The Fort Folly First Nation fish LFA 35 lobster licences out of Parrsboro. As stated previously, most lobster fishing takes place along the Blomidon, Scots Bay and Parrsboro shores, and is concentrated nearshore although traps are occasionally set in deeper, high current areas. Aboriginal people are permitted to fish for food, social and ceremonial purposes as well, but no specific issues associated with this type of fishery were identified. It is expected that there limited activity of this nature in the Project area, due to the high currents and limited Aboriginal population in the area.

A Mi'kmaq Ecological Knowledge Study (MEKS) was commissioned in April 2009 and is scheduled for completion in early August 2009, and is jointly funded by FORCE (at this time, Minas Basin Pulp and Power) and the province of Nova Scotia.

The MEKS will include:

- A historic and current study of Mi'kmaq land and resource use in the Project area;
- An evaluation of the potential impacts of the Project on Mi'kmaq land and resource use and occupation and constitutionally based rights;
- An evaluation of the significance of the potential impacts of the Project on Mi'kmaq use and occupation; and,
- Recommendations that may include mitigation measures, further study, or consultation.

The final MEKS report will be provided to the provincial and regulatory agencies upon completion.

3.4.7 Archaeological, Heritage and Cultural Resources

3.4.7.1 Unknown Resources

The history of human occupation in Nova Scotia has been traced back approximately 11,000 years to the Paleo-Indian or *Saqiwe'k Lnu'k* period (11,000 – 9,000 years BP). The only archaeological evidence of Paleo-Indian settlement in the province is found at Debert/Belmont in Colchester County. This period was followed by the *Mu Awsami Sagiwe'k* (Archaic) period (9,000 – 2,500 years BP) which included several traditions of subsistence lifestyles. The coastal Maritime Archaic people exploited mainly marine resources, while the inland Shield Archaic concentrated on interior resources such as caribou and salmon. The

Laurentian Archaic is generally considered to be a more diverse hunting and gathering population than the Maritime Archaic group (Davis Archaeological Consultants Limited 2008).

The first European settlers in the Project area were the Acadians who arrived at the western mouth of Parrsboro Harbour near Partridge Island in 1670. They were later expelled by settlers from New England in the mid-to-late 1700's. As early as 1776, Parrsboro, then known as Partridge Island, was a relatively important shipbuilding and fishing settlement which was subsequently renamed the Township of Parrsboro in 1784, after Nova Scotia Governor John Parr. The Town of Parrsboro was later incorporated in 1889 (Parrsboro Economic Development Committee 2008).

In order to assess the existing conditions within the Project area, an archaeological resource impact assessment was undertaken in 2008 by Davis Archaeological Consultants Limited (Appendix 10). The assessment included a historical background desktop study to identify areas with high potential for archaeological resources, as well as a field reconnaissance on September 19-20, 2008. Both activities were conducted under Heritage Research Permit # A2008NS72 and in conformity to the standards required by Nova Scotia Department of Tourism, Culture and Heritage (NSDTCH) Heritage Division under the Special Places Program.

Desktop review of the Maritime Archaeological Resource Inventory at the Nova Scotia Museum revealed an isolated find in the Project area (several glass trade beads from the post-contact period) attributed to indigenous historic activity. The background research indicated the study area had high potential for archaeological resources related to late eighteenth and nineteenth century occupation of the area. The likelihood of encountering Mi'kmaq archaeological resources was also considered high on the shore of the Bay of Fundy. The desktop study additionally identified two vessels grounded on Black Rock, while other identified vessels were considered to be outside of the Project area. Since the Minas Passage is considered a high energy site, shipwrecks are not expected to last long on the seafloor.

In addition to the background research, field reconnaissance was undertaken and eventually focused on two areas: the remains of a house cellar situated immediately west of the proposed easement, and a small ravine leading from West Bay Road down to the shoreline. Artifacts consistent with nineteenth century occupation were recovered at both the cellar site and the ravine. The archeologists conclude that the cellar feature has been heavily disturbed in recent years and little may remain below the surface of the original structure. In addition, cultural material observed in the ravine is not considered to be of great archaeological significance (Appendix 10).

No cultural resources or shipwrecks were observed on the beach and shoreline and no evidence of First Nation or Aboriginal Peoples' activity were noted. Nearby property owner Lea Pelletier reported finding some sandstone net weights along the shore; however, the archeologists concluded that these weights were of historical rather than pre-contact origin. They note the beach is in a constant state of change due to natural forces of tidal and storm activity and has not preserved any elements of significant cultural activity that may have occurred there.

3.4.7.2 Known Resources

The Springhill and Parrsboro Railway began service to the town from the coal mining town of Springhill on July 1, 1877. Parrsboro became a coal shipping port for the Springhill mines, primarily serving Saint John, New Brunswick. Railway service to Parrsboro was abandoned on June 14, 1958, following several years of declining shipments, several months before the 1958 mining disaster.

Throughout the late 19th century and first four decades of the twentieth century, Parrsboro saw daily ferry service across the Minas Basin to the Annapolis Valley ports of Kingsport and Wolfville. The 13th and final vessel in this service, operated by the Dominion Atlantic Railway, was the MV *Kipawo*, which is now permanently beached at Parrsboro and incorporated into the Ship's Company Theatre performance centre.

A Handley Page V/1500 aircraft named *Atlantic* made a forced landing in Parrsboro July 5, 1919. When the starboard engine failed the pilot, Major Brackley saw the lights of the town during the night and landed. After three months, the aircraft was repaired and departed for Greenport, New York, Parrsboro's sister town. The local Air Cadet Squadron, 689 Handley Page, is named after this event.

In 1985, Parrsboro resident Eldon George unearthed the biggest fossil find in North America at Wasson's Bluff on the North Shore of the Minas Basin near Parrsboro. This discovery consisted of more than 100,000 pieces of 200 million year old fossils. This find constitutes the largest single collection of fossils and the first fossils of a series of dinosaur footprints, each the size of a penny, which are the smallest ever discovered. The prints are now on display at the Parrsboro Rock and Mineral Shop and Museum, owned by Mr. George (Parrsboro Economic Development Committee 2008). The Parrsboro Fossil Site located on Wasson's Bluff approximately six km from Parrsboro was designated a Special Place under the terms of the *Special Places Protection Act* on March 1, 1990 (Nova Scotia Museum 2008).

Of the three museums in Parrsboro, two are dedicated to geological history. The Fundy Geological Museum, located along the eastern shore of Parrsboro Harbour, and the Parrsboro Rock and Mineral Shop and Museum, along the western shore, display many discoveries and provide information on the natural history of the region. The third museum (built between 1765 and 1775) is the Ottawa House which contains evidence of Acadian construction and several later additions. Located along the western coast of Parrsboro Harbour near Partridge Island, Ottawa House was the summer home of Father of Confederation (and later Prime Minister). The museum focuses on Parrsboro's shipbuilding history and has many artifacts that date to the Age of Sail (Parrsboro Economic Development Committee 2008).

3.4.8 Transportation and Navigation

A Phase 1 Marine Transportation Study for the Proposed Fundy Tidal Power Demonstration Facility Project was undertaken in May of 2008 by Gartner Lee Limited (now AECOM). The study investigated commercial shipping activities in the Minas Channel to assist the preliminary site selection survey by identifying “no go” areas for the potential Demonstration Facility sites.

The management of marine traffic for the Minas Channel area is the responsibility of the Canadian Coast Guard’s Fundy Marine Communication and Traffic Services Centre (Fundy MCTS) based in Saint John, New Brunswick. Based on direct communications with the Officer in Charge (OIC) at Fundy MCTS, the following was confirmed:

- There are no shipping lanes for the approaches to the Minas Channel;
- The vast majority of large vessels moving through the Minas Channel are the gypsum bulk carriers (almost 100%, as discussed further below); and
- Infrequent large recreational vessels visit the area (those > 30 m in length). The last one of this size was a several years ago visiting the Parrsboro area.

The Atlantic Pilotage Authority confirmed there are no mandatory pilotage requirements for the Minas Channel area and their pilots are not used due to the familiarity of the gypsum bulk vessel operators with the

Minas Channel and Basin. The nearest shipping lane is in the outer part of the Bay (far removed from the Minas Channel area, approximately 1 km away) and is called the Bay of Fundy Traffic Separation Scheme. It was established in 1982 to organize vessel traffic through an area used extensively for fishing, and is mandatory for all vessels of 20 m in length. In 2003, changes to this shipping lane came into effect to protect the endangered North Atlantic right whale. All large vessel traffic movement in the Bay of Fundy must report to the Fundy MCTS at specified points in the Bay, based on following criteria (see Hydrographic Chart # 4010 for locations):

- All merchant/commercial vessels > 20 m in length;
- All fishing vessels > 20 m in length; and,
- All recreational vessels > 30 m in length.

The Aids to Navigation Branch of DFO indicated that there are no large floating buoys located in the Minas Channel or Basin areas and therefore, no Canadian Coast Guard (CCG) vessels operate in the Minas Channel area on a routine basis. Canadian Coast Guard or other DFO vessels may sail in the area, but this would only be for special surveys; even these larger vessels would not have drafts of greater than 4 - 5 m.

The Conservation and Protection Branch of DFO indicated that Fishery Patrol Vessels operate on an infrequent basis, with the number of patrols varying from year to year. DFO's largest patrol vessel used in the Minas Channel/Basin has a draft of less than 2 m. DFO also noted that the largest fishing boats operating in the Minas Channel/Basin area have similar dimensions, but with a slightly larger draft when fully loaded (*i.e.,* 2.5 m) (Smith pers. comm. 2008)

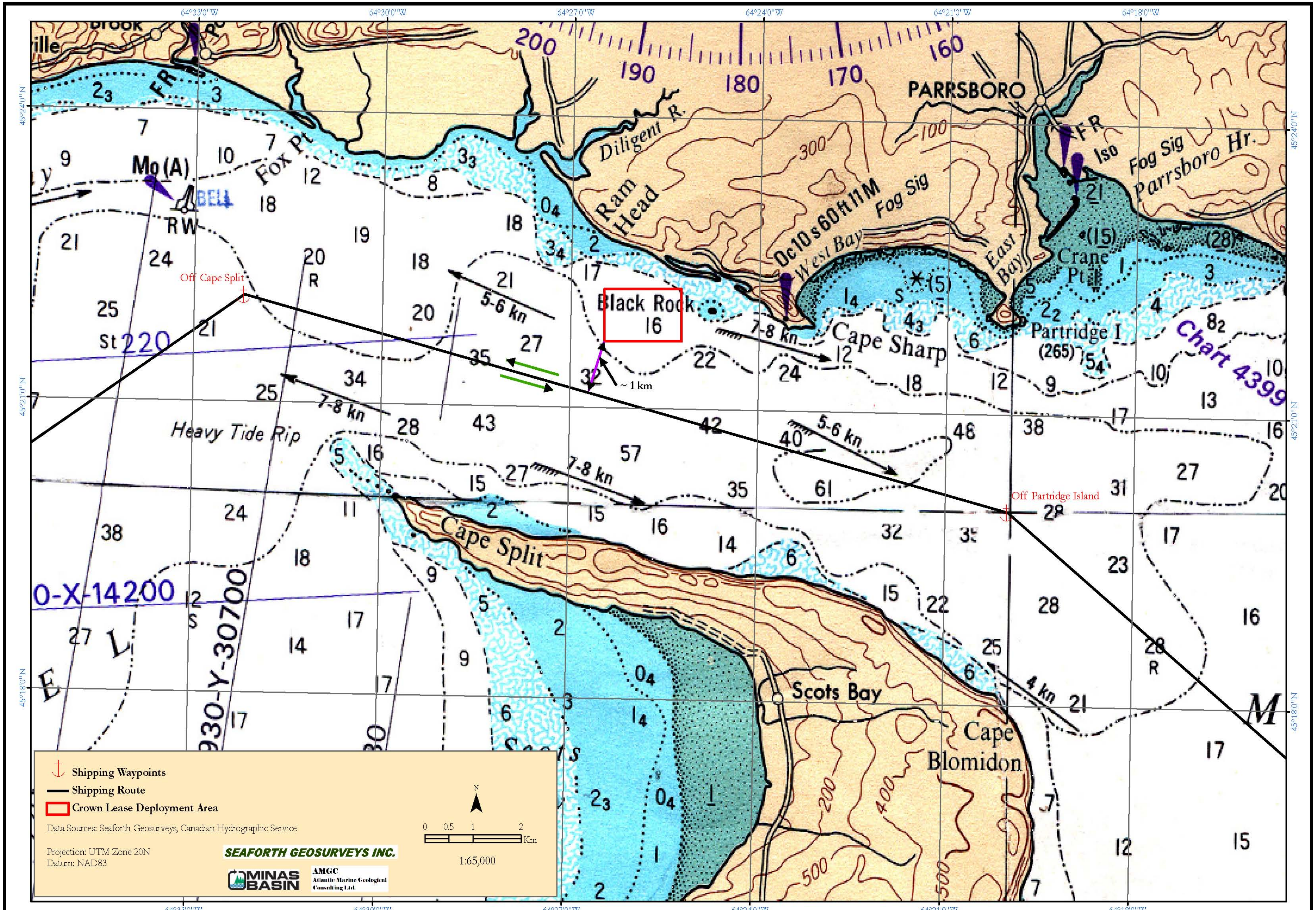
As noted earlier, the largest and most frequent commercial vessels moving through the Minas Channel/Passage are exclusively gypsum bulk carriers with a maximum draft of 10 m when fully loaded, sailing at high tide or falling high tide (Burger pers. comm. 2008). Based on discussions with Fundy Gypsum Company, loaded gypsum vessels sail through the deepest part of the Minas Passage generally tending to the Cape Split (southern) side. There are between 200 to 250 gypsum vessel transits through the Minas Passage on an annual basis. The gypsum vessels have anchorages on either side of the Minas Passage (*e.g.,* near Scots Bay and Cape Blomidon), and do not sail through the Passage during poor weather conditions. Figure 3-16 shows the gypsum bulk vessels main route and anchorages in the Minas Channel relative to the proposed Demonstration Facility and cable corridor. As Figure 3-16 illustrates, the closest the shipping route approaches the edge of the Demonstration Deployment Area is 1 km.

In addition, the sea state or wave potential for the Minas Channel is relatively small, with waves generally in 1 - 2 m range, due to the low windspeeds and the short distances over water to generate waves. However, the largest seas in the Minas Basin can develop over western sections with easterly gales on the flood tide. This can produce a 3 - 3.5 m short steep sea. Although strong coastal winds do occur from Economy Point to Cape Chignecto, particularly easterlies, this stretch of coastline is well sheltered from northerlies and northwesterlies.

As noted above, the proposed Demonstration Facility is nearer to the Parrsboro side of the Minas Passage (approximately 1.5 km from shore) and the TISEC devices will be located in areas with depths between 30 - 45 m at low low tide, with clearances above the devices of approximately 15 m at low tide. The surface piercing tower is required for the third TISEC device, projecting approximately 8.5 m above sea level at high tide and 21.5 m at low tide, and the structure will be lighted and clearly marked to meet all safety and navigational requirements as directed by Transport Canada.

The number of vessels utilized for the deployment of the turbines and cables will be a relatively small (4 - 5 vessels). It is anticipated that these vessels will be operating in the July to October period of the years 2009, 2010 and possibly 2011, when the lowest number of gypsum vessels are sailing in the Passage area (estimated between 4 - 6 per month, Bulger, Langdon, pers. comm. 2008). Turbine and cable deployment will be scheduled, to the extent possible, during non-lobster fishing season (Aug. 1 – Oct. 14).

Figure 3-16 – Gypsum Carrier Routes & Anchorages



Interaction between Project vessels and commercial shipping and fishing vessels will be minimized by operating during summer months (non-lobster fishing seasons), advising stakeholders of the Project vessel movements, providing Notice to Mariners during construction and decommissioning activities, and equipping surface piercing structures with all appropriate markings, lights and radar reflectors as required by regulations. Project vessel operators will follow standard marine operational protocol, such as advising approaching vessels by radio during deployment activities. Surface piercing stuctures will be charted and its coordinates provided to mariner in the area and included on updated Hydrographic Charts.

A proposed 300 m radius fishery/safety exclusion area around the structure will be put in place (the size may change based on the NWPA permit conditions).

In addition to the Notice to Mariners during Project vessel movement, and updated Hydrographic Charts and coordinates for the structures, there will be ongoing communication regarding the scheduling of vessel activities with the local fishing industry via the Fisheries Contact Committee and direct communication with the Fundy Gypsum Company.

Minas Passage is not a major recreational boating area, either in terms of power boating, sailing or sea kayaking due to the high currents and large range of tides in the area.

Generally, the area of the on-shore facility receives very little traffic other than movements of local residents and occasional visits by tourists and other outdoor enthusiasts. Road access (West Bay Road) is currently provided to the private land on which the land-based facility will be constructed. Approval or authorization is not likely to be required from the provincial Department of Transportation and Public Works since it not necessary to build a road to the land-based facility. At present only a short (15 m) access road connecting West Bay Road to the facility's parking lot will be required. The small channel entering the saltmarsh considered to be fish habitat is not considered to be a navigable watercourse. The salinities in the pond were estuarine, indicating recent salt water influence and negligible quantities of freshwater entering the pond. The channel is no more than 15 cm deep at low tide and the widest section is about a metre, near the pond. The inlet to the pond (upstream) is about 0.6 m feet wide and 0.3 m deep and appears to be a local drainage channel only.

3.4.9 Aesthetics and Visual Landscape

The world's highest tides occur in the Minas Basin, with the maximum tidal range recorded at 16.8 m. Parrsboro, the largest seaport on the Minas Basin, affords the best view of this tidal phenomenon. Parrsboro is an historic seaside town nestled into the shores of the Minas Basin. At this point the tide floods and ebbs over 3.2 km of tidal flat from the low water mark to the head of the harbour. Each phase of the cycle takes approximately 5 hrs and 40 min (Parrsboro Economic Development Committee 2008).

Based on the present scenario for the MCT turbine generator, there will be a visible portion of the turbine's support structure projecting above the sea surface, approximately 21.5 m above sea level at low low tide. Although this structure will not be visible from Parrsboro, the above water structure will be lighted and clearly marked to meet all safety and navigational requirements. Such a change to the visual landscape or aesthetics of the Black Rock area has not been raised as a concern by local residents, stakeholders, or Aboriginal Peoples' communities, possibly due to the potential for the Demonstration Facility to attract further eco-tourism to the area.

4. Environmental Impact Assessment Methods and Scoping

4.1 Assessment Methodology

The environmental assessment methodology for the Project has been developed to satisfy regulatory requirements for a screening level assessment pursuant to the *CEAA* and an environmental assessment for a Class I Undertaking under the Nova Scotia Environmental Assessment Regulations.

The approach and methodology used are based largely on the work of Beanlands and Duinker (1983), the Canadian Environmental Assessment Agency (1994, 1997, 1999a,b) and Barnes *et al.* (2000), as well as the study team's expertise in conducting environmental assessments. The approach and methods used have proven very effective for assessments conducted under federal, provincial, joint federal-provincial and multi-party processes, as well as for environmental assessments in various jurisdictions throughout the world.

Assessing all of the potential issues associated with a proposed undertaking is impractical, if not impossible (Beanlands and Duinker 1983). It is therefore generally acknowledged that an environmental assessment should focus on those components of the environment that are valued by society and/or that serve as indicators of environmental change. These components are known as **valued ecological components** or VECs. Section 4.2 describes the issues scoping and VEC selection process undertaken for this assessment. The environmental assessment for the Project evaluates the potential effects, including cumulative effects, of each Project with regard to each VEC. The cumulative effects assessment, including details on methodology and approach is included in Section 8.0. The following subsections describe how the environmental effects assessment for each valued environmental component (VEC) is organized in this report.

4.1.1 VEC Identification and Description of Ecological and Socioeconomic Context

To ensure that the assessment is holistic, the CEA Agency guidance documents (1994) require a description of the environmental context for each VEC. The consideration of the current state of a VEC and any Project-related effects requires an evaluation of the relationship of each VEC with other components of the ecosystem or human systems (*i.e*., trophic relationships). A detailed description of each VEC to be assessed is provided in Section 3.0.

4.1.2 Boundaries

An important aspect of the effects assessment process is the determination of the boundaries of the assessment. Temporal and spatial boundaries encompass those periods during, and areas within which, the VECs are likely to interact with, or be influenced by, the Project. These boundaries may extend well beyond the limits of direct disturbance (*e.g.,* migratory species whose range extends beyond the area of physical disturbance associated with the Project). Other boundaries to be considered as appropriate include administrative and technical boundaries imposed by factors such as finite resources of data, time, cost, and labour, as well as technical, political, or administrative considerations or jurisdictions.

4.1.3 Establishment of Residual Environmental Evaluation Criteria

Section 16(1)(b) of the *CEAA* specifically requires that the significance of environmental effects be determined. Accepted practice in meeting this requirement involves establishing evaluation criteria for the determination of significance.

The CEA Agency (1994) lists criteria that should be taken into account in deciding whether adverse environmental effects are significant. These criteria include, among other factors:

- Magnitude;
- Geographic extent;
- Duration;
- Frequency;
- Reversibility; and
- Ecological and/or socio-cultural context.

These criteria have been considered in this assessment with regard to the determination of significance for each VEC. It is also necessary to define the threshold beyond which an effect is considered, for the purpose of this assessment, to be significant. For each VEC, a definition is provided for 'significant adverse environmental effect' and 'positive effect'. These significance definitions are generally population or community-based, but may be based on regulatory standards or limits, where these exist for a particular VEC.

4.1.4 Potential Issues, Interactions, and Concerns

Potential interactions with VECs (*i.e.,* a description of the degree to which the VECs are exposed to each Project activity), are described in the assessment. Where appropriate, the assessment includes a summary of major concerns or hypotheses of relevance regarding the effect of each Project activity on the VEC being considered. Where existing knowledge indicates that an interaction is not likely to result in an effect, certain issues may not warrant further analysis.

4.1.5 Analysis, Mitigation and Residual Environmental Effects Prediction

The assessment focuses on the evaluation of potential interactions between the VECs and the various Project activities outlined in the Project Description. A standard evaluation system has been developed to ensure that potential effects are clearly and completely evaluated. The prediction of residual effects follows three general steps, as outlined by the CEA Agency (1994):

- Determining whether the environmental effects are adverse;
- Determining whether the adverse environmental effects are significant; and
- Determining whether the significant adverse environmental effects are likely to occur.

Mitigation includes environmental design, environmental protection strategies, and mitigation specific to the reduction or control of potential adverse environmental effects on a particular VEC. As required by *CEAA*, these measures must be technically and economically feasible. Depending on the anticipated environmental effects, the mitigation and enhancement strategies are optimized to minimize adverse environmental effects and enhance those that are positive. The effects predictions are of residual adverse environmental effects (*i.e.,* after all mitigation, including compensation, is applied).

4.1.6 Follow-up and Monitoring

Section 16(2)(c) of *CEAA* requires consideration of the need for, and requirements of, any follow-up studies. Follow-up and EEM programs provide essential feedback, in particular with respect to:

- Predicted project effects;
- Unanticipated effects;
- The necessity and efficacy of project management strategies; and
- Cumulative effects.

Monitoring by the proponent may be undertaken for a number of reasons including regulatory or corporate compliance (environmental compliance monitoring or ECM), evaluation of mitigating measures, strengthening predictive capacity in future Environmental Assessments, and commitments to third parties.

Monitoring and follow-up requirements are evaluated for each VEC and are linked to the sensitivity of a VEC to both Project-related and cumulative environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with the adverse residual effects rating, are also taken into consideration.

4.1.7 Summary of Residual Environmental Effects Assessment

This section summarizes the adverse environmental effects on each VEC. It also addresses the likelihood of all predicted significant adverse effects. The likelihood of a significant adverse environmental effect is based on scientific knowledge with reference to statistical significance, quantitative risk assessment, or professional judgement.

4.2 Scoping and Selection of Valued Environmental Components

A scoping exercise was undertaken early in the Project EA process. This exercise was conducted by the study team to identify an appropriate list of VECs upon which the assessment can be focused for a meaningful and effective evaluation. The scoping exercise included:

- Review of the Fundy Tidal Energy Strategic Environmental Assessment Report prepared by the Offshore Energy Environmental Research (OEER) Association and the Background Report for the Fundy Tidal Energy Strategic Environmental Assessment prepared by Jacques Whitford Limited *et al*. 2008;
- Formal and informal discussions regarding potential environmental interactions with DFO; Environment Canada; Nova Scotia Department of Energy; Nova Scotia Environment, Nova Scotia Museum; Nova Scotia Department of Natural Resources; and Transport Canada;
- Review of listed species and/or species-at-risk found within the Project area using existing regional information and/or site surveys;
- Discussions with government scientific authorities (*e.g.*, NSDNR species-at-risk experts, DFO biologists, Environment Canada experts);
- Stakeholder consultations and First Nations and Aboriginal Peoples' engagement conducted specifically for the Project as well as consultation conducted in support of the SEA and Background Report; and

- The professional judgment of the Proponent's Study Team.

Section 5.0 of this report provides a detailed description of the consultation program undertaken specifically for the proposed Project. Information from this process assisted the identification and scoping of VECs for the environmental assessment. FORCE's ongoing consultation program involves continued communication with stakeholders and regulators during the review of the application as well as during the design, development, operation, and decommissioning of the Facility.

The environmental issues considered are shown in Table 4-1, along with the rationale for inclusion/ exclusion as a VEC.

Table 4-1 VEC Selection

Environmental Issue	Project Interaction	Scoping Considerations	VEC
Atmospheric Environment			
Air Quality	Air emissions from vehicles and equipment exhaust during all Project phases and dust generated during construction / decommissioning.	Given the scale of the Project (*i.e.,* Demonstration Facility), generation of air emissions that could reduce air quality is very low. Vehicles and equipment will be regularly inspected and maintained and idling of equipment will be minimized to the extent practical. With above mitigation, the potential for significant adverse environmental effects is not likely. No further assessment required.	N/A
Acoustic Environment	Noise generated by vehicles and equipment during all Project phases.	Given the scale of the Project and the limited extent and duration of activities, noise generated by construction and decommissioning activities will be intermittent and minimal. Noise emissions generated will not exceed the NSE provincial guidelines at the property boundaries of the site. Significant adverse environmental effects are not likely to occur. Noise generated by operation of subsea turbines is addressed in the relevant biophysical VECs. No further assessment is required.	N/A
Climate	If demonstration is successful, there are implications for long-term benefits in terms of climate change (*i.e.,* reduced greenhouse gas).	The Demonstration Facility will not realize any measureable benefits in terms of climate change. No further assessment is required.	N/A
Terrestrial Environment			
Soil Quality	Potential for accidental fuel spill during construction.	A spills contingency plan for land-based activities will be developed and included in the Project EMP. With proper implementation of the plan, significant adverse environmental effects are not likely to occur. No further assessment is required.	N/A
Surface Water Quality	Potential for siltation of surface water during construction and decommissioning. Potential for contamination as a result of accidental spills during construction, operation, and decommissioning.	Water quality is inherently linked to wildlife habitat quality for species. Public and professional concern exists regarding species of special status protected under *SARA* and associated habitat that may occur in the area. Provisions for discharging into aquatic environments also exist under the *Fisheries Act*. A spills contingency plan for land-based activities will be developed and included in the Project EMP. With proper implementation of the plan, significant adverse environmental effects are not likely to occur.	Intertidal Environment

Groundwater Quality	Potential for contamination as a result of accidental fuel spill during on-land construction or decommissioning. Potential construction, operation and decommissioning related effects on local groundwater users.	A spills contingency plan for land-based activities will be developed and included in the Project EMP. With proper implementation of the plan, significant adverse environmental effects on groundwater quality are not likely to occur. The activities associated with construction and decommissioning of the facility will have limited to no interaction with groundwater resources (*i.e.*, minor excavation and no blasting anticipated). A water supply well to service the building (domestic/office use) and an on-site septic field will be developed. All required municipal and provincial permits will be obtained. Significant adverse environmental effects are not likely to occur. No further assessment required.	N/A
Wildlife and Wildlife Habitat	Potential for physical damage/loss of vegetation and wildlife habitat due to construction. Potential for disruption/displacement of birds, mammals, amphibians through noise, light, traffic etc.	Construction of the land-based facilities (*i.e.,* cable, substation, power transmission lines) will result in the loss of vegetation and habitat present at the site. Species of special concern are protected under the *SARA, MBCA,* Nova Scotia *Endangered Species Act* and the Nova Scotia *Wildlife Act*. The focus of concern is on protection of species biodiversity and unique or uncommon habitats.	Wildlife and Wildlife Habitat
Species at Risk	Potential for harm/displacement of Species at Risk (SAR): plants, animal and birds.	Protection of species biodiversity is administered through the *SARA*, Nova Scotia *Endangered Species Act*, Nova Scotia *Wildlife Act* and *MBCA.*	Terrestrial Species At Risk
Marine Environment			
Currents, Tides, and Sediment Transport	Removing energy from the water column may result in changes to current velocity, scouring patterns and sediment distribution. These changes may affect food distribution and aquatic biota as well as turbidity levels throughout the water column.	The SEA, the Background Report, and the Study Team acknowledge that this issue is not well understood; however, it is further acknowledged that a demonstration scale project will not likely have any measureable effects on these physical processes beyond the immediate area (OEER 2008). An objective of the Demonstration Facility is to gather information that will serve to further evaluate the potential effect for a larger scale development. The monitoring program will include monitoring of currents and other related aspects. Environmental effects are not likely to be significant. No further assessment required; however, monitoring for the purpose of modelling for larger scale developments is proposed.	N/A

Marine Water Quality	Potential for accidental events/ spills during installation, maintenance, or decommissioning. Potential for corrosion of protective coatings. Potential for temporary increased turbidity and suspended sediment during deployment, maintenance, and decommissioning. Potential for increased turbidity from seafloor scouring due to the presence of turbines. Potential heating of the water column by NSPI device.	A spills contingency plan for marine activities will be developed and included in the Project EMP. With proper implementation of the plan, significant adverse environmental effects are not likely to occur. Similar to surface water quality, marine water quality is inherently linked to habitat quality for marine species. Public and professional concern exists regarding species of special status protected under the *SARA* and associated habitat that may occur in the area. Provisions for discharging into aquatic environments also exist under the *Fisheries Act*. Marine water quality will be discussed with relevant biophysical components.	Marine Mammals Marine Fish and Water Quality
Acoustic Environment	Increases to ambient noise from boats and equipment during construction, operations & maintenance, and decommissioning. Increases to ambient noise from the operating turbines.	Increased noise and vibration in the marine environment has the potential to directly or indirectly adversely affect marine mammals, fish, and other marine wildlife species. The extent of this issue is not well understood. An objective of the demonstration facility is to gather information that will serve to further evaluate this potential effect, particularly for a larger scale development. The potential environmental effects of this issue are explored and a data collection and monitoring program will be developed.	Marine Mammals Marine Fish and Water Quality
Intertidal Environment (*i.e.*, salt marsh, beach, tide pools, watercourse)	Potential for disruption (*e.g.*, sedimentation) of pond and watercourse and adjacent/associated salt marsh habitat during cable laying. Potential for harm to fish and fish habitat associated with watercourse crossing during cable installation and potentially decommissioning. Potential for accidental events/spills during installation, maintenance, or decommissioning.	The intertidal environment includes sensitive aquatic habitat. Public and professional concern exists regarding species of special status protected under *SARA* and associated habitat that may occur in the area. Provisions for discharging into aquatic environments also exist under the *Fisheries Act*. A spills contingency plan for land-based activities will be developed and included in the Project EMP. With proper implementation of the plan, significant adverse environmental effects are not likely to occur.	Intertidal Environment
Benthic Habitat and Communities	Destruction or disruption of benthic fauna due to installation, and decommissioning of turbines and cable. Potential changes of current patterns to sediment deposition/distribution. Biofouling of TISEC devices.	The marine benthic community is important as a component of the marine ecosystem and also in its connection to commercial fisheries. Environmental effects on benthic fauna may affect the success of finfish or shellfish populations in the area. The marine benthos section considers water quality, sediment quality and benthic invertebrates.	Marine Benthos

Fish and Fish Habitat	Potential disruption to spawning and migration patterns, fish strikes due to presence of turbines. Loss of fish habitat due to the device and cable installation. Creation of new habitat around GBSs. Potential changes to fish behaviour due to noise/ vibration/ EMF and sediment (food) distribution. Potential decrease in reproductive success due to changes in current patterns/velocities, changes to sedimentation. Potential effects from accidental events/spills during installation, maintenance, or decommissioning.	Marine fish are an important component of the marine ecosystem and play a significant role in the stability of commercial fisheries. Environmental effects on the marine fish community may in turn affect commercial fisheries and other ecosystem components that rely on several species of marine fish as a food source. Fish and fish habitat are protected by the federal *Fisheries Act*. Species at risk are protected under the *SARA* (see below). Public concern exists for marine fish and fish habitat in the area. Fish habitat in the vicinity of the Project area supports commercial, recreational and Aboriginal fisheries.	Marine Fish and Water Quality
Species at Risk	Potential disruption to spawning and migration patterns, fish strikes, loss of fish habitat due to the Project footprint. Potential changes to fish behaviour due to noise/vibration/EMF and sediment (food) distribution. Potential decrease in reproductive success due to changes in current patterns/velocities, changes to sedimentation. Potential effects from accidental events/spills during installation, maintenance, or decommissioning.	Under *SARA*, activities that increase risks to listed species must be carefully considered. There are 22 *SARA* listed species that occur in the Bay of Fundy (five mammal, eight bird, nine fish), most of which occur in the Outer Bay areas.	Marine Species at Risk
Seabirds and Waterfowl	Potential for changes in food availability. Potential for changes in behaviour or breeding due to human activity. Potential changes to the distribution/migration due to surface tower and lights. Potential effects from accidental events/spills during installation, maintenance, or decommissioning.	Protection of migratory species and species of concern are mandated by the *MBCA*, *SARA*, Nova Scotia *Endangered Species Act* and Nova Scotia *Wildlife Act*. The focus of concern is on protection of species diversity, migratory and non-migratory birds, rare or sensitive species potentially feeding, breeding, moving and/or migrating through the Project area.	Marine Birds

Marine Mammals and Sea Turtles	Potential for direct strikes on the turbines. Potential changes to migration, breeding, feeding patterns due to vessel traffic, lights, device noise, vibration and/or EMF. Potential changes in distribution as a result of change in food and prey species. Potential effects from accidental events/spills during installation, maintenance, or decommissioning.	Marine mammals are considered as a VEC due to their potential interactions with the Project, significant role in the marine ecosystem, scientific and public concern, regulatory protection and potential economic implications associated with the whale-watching industry. This analysis considers mammals that may live or migrate through the study area. Sea turtles are highly unlikely to occur in this part of the inner Bay of Fundy and are therefore not included in this VEC.	Marine Mammals
Human / Socio-economic Environment			
Recreational and Commercial Fisheries	Potential reduction in catch sizes due to death/disruption of lobsters and other species from noise/vibration, EMF or other factors. Loss of fishing grounds and potential reduction in catch sizes due to the exclusion zone around the turbines. Displacement and crowding of fishing activity due to exclusion zone. Potential damage to boats and fishing gear.	Recreational and, in particular, commercial fisheries are of major economic and social importance to the communities in the Bay of Fundy. The potential disruption or displacement of fishing activity as a result of the Project is an important environmental/socio-economic consideration.	Recreational and Commercial Fishing
First Nations and Aboriginal Land and Resources Use	Potential restriction of access to commercial fisheries, social-ceremonial sites. Potential damage to areas of cultural interest (archaeological sites, plant collection sites).	Consideration of First Nations and Aboriginal land and resource use in this assessment is important due to the potential interest of First Nations use of land and resources.	Recreational and Commercial Fishing Archaeological and Heritage Resources MEKS Study
Archaeological and Heritage Resources	Potential damage to marine and or terrestrial archaeological sites, including First Nations/Aboriginal Sites.	Archaeological and heritage resources are administered under the Nova *Scotia Special Places Protection Act*. For the purpose of this study, archaeological and heritage resources include both land-based and marine artefacts. Concerns exist with the effective management of archaeological and heritage resources.	Archaeological and Heritage Resources
Tourism and Recreation	Potential interaction with sea kayaking and recreational boating during all phases (*i.e.,* when actively working with the devices and or cable). Potential positive impacts identified by tourist operators (*i.e.*, ecotourism), SEA and other public participants.	Marine and land-based tourism and recreational activities rely on the Bay of Fundy and the Minas Passage area.	Tourism and Recreation

Marine Transport and Navigation	Potential disruption to shipping and navigation causing economic impacts to shippers. Potential disruption to local boaters/recreational fishers/tour operators due to anchorage restrictions and exclusion zone. Potential increase of marine safety concerns.	Marine transportation and navigation are regulated under the *NWPA*. Other relevant legislation includes the *Ocean's Act, Canadian Marine Act* and the *Canada Shipping Act*. Transport Canada advised that marine transportation and navigation will be managed via the *NWPA* process and is not required as a VEC (see Section 3.4.8).	N/A
Aquaculture	Potential disruption to aquaculture operations identified in SEA.	Through consultation, Study Team has confirmed that there are no aquaculture sites or activities in the vicinity, nor are any proposed, that could potentially interact with the demonstration facility.	N/A
Other Seabed Uses and Activities	Potential for disruption to dulse harvest at Black Rock. Disruption to potential use such as ocean dumping, exploration, military and research activities.	Anecdotal accounts of dulse harvesting have been recorded but no commercial operation has been identified. Project is not expected to interact with dulse harvesting. There are no other ocean uses in the area that could potentially interact with the Project.	N/A
Visual Environment	Potential negative perception of surface piecing tower by residents of West Bay Road. Potential negative perception of electrical facility. Potential for disruptive noise and traffic during construction	Concerns related to visual aesthetics have not been raised during Project related consultation and communications. This may be a result of the relative small scale of the Project and the potential positive effect of an increase in ecotourism. There is no legislation protecting a viewshed. No further assessment is required.	N/A
Local Economy	Potential positive impacts from use of local resources, boats, ports and increased tourism.	FORCE will take as many opportunities as practical to involve and engage local resources in the project. Given the limited extent and duration of the demonstration project, significant positive effects on the local economy are not anticipated.	N/A

In summary, the environmental assessment of the Project will focus on the following VECs:

- Marine Benthos;
- Marine Fish and Water Quality;
- Marine Mammals;
- Marine Birds;
- Marine Species at Risk;
- Intertidal Environment;
- Terrestrial Wildlife and Wildlife Habitat;
- Terrestrial Species at Risk;
- Recreational and Commercial Fishing;
- Archaeological and Heritage Resources; and
- Tourism and Recreation.

5. Consultation and Community Involvement

As a result of the Strategic Environmental Assessment (SEA) process there was significant interest and a fairly high level of awareness of the Tidal Energy Project in the Parrsboro and Wolfville areas.

Prior to the final SEA outcome, it was recognized that early community and Aboriginal Peoples' engagement are central to identifying and responding to concerns and questions raised by these communities in relation to the proposed Project. It was also an excellent opportunity to build on the awareness and profile of the tidal energy issues generated by the SEA process.

The pre-project engagement process was initiated in January, 2008 by contacting a representative cross-section of key stakeholders and Aboriginal Peoples' communities, primarily in the Parrsboro area, but also on the Annapolis Valley side.

The intent of this initial pre-project engagement was threefold:

- To provide accurate information on the proposed Project;
- To present an opportunity for stakeholders to express their issues and concerns; and,
- To understand how the various stakeholders would like to be engaged and consulted as the Project proceeded.

Subsequent to the SEA decision in June 26, 2008, a proactive engagement program was initiated as detailed under Section 5.2.1.2. The objectives of this program were:

- To present the affected communities with up to date information related to the Project activities;
- To provide an opportunities for feedback on issues and concerns of the affected communities, stakeholder groups, individuals and Aboriginal Peoples.
- To fulfill any regulatory engagement and consultation requirements of the federal and Nova Scotia governments.

5.1 Regulatory Consultation

Nova Scotia does not require proponents to involve the public in the pre-registration stage of a project but the project proponent may decide how the public should be involved. Formal consultation with the public is a responsibility of the Province under the Nova Scotia *Environment Act*, and is accomplished by the public review period of 30 days after the Registration Document is submitted, and upon completion of the EA. In accordance with Section 12 of NS Environmental Assessment Regulations, the Minister of the Environment will take the concerns expressed by the public into account when making a decision on the project, including conditions for approval, or non-approval.

Requirements for public consultation at the federal screening level environmental assessment are the responsibility of the Responsible Authorities (RA), which for this project are DFO and Transport Canada. Similar to Nova Scotia requirements, the RAs will take public concerns into account in their decision making process.

However, both levels of government strongly encourage proponents to engage the public and Aboriginal Peoples communities as early as possible in the development of the project.

Formal consultations with Aborignal Peoples regarding the Project is the responsibility of the Nova Scotia and Federal Governments, and is accomplished by both levels of governments, in Nova Scotia by meeting with the individual First Nations and/or the Assembly of Nova Scotia Mi'kmaq Chiefs and the Kwimu'kw Maw-klusuaqn (Mi'kmaq Rights Initiative – KMK).

5.2 Communications with Government Agencies

Beginning in the summer of 2007, there have been ongoing telephone discussions and meetings with federal and provincial government officials to discuss aspects of the Project and to obtain clarification on regulatory requirements and approvals, federal-provincial harmonization, and scheduling. Table 5-1 below summarizes the key government officials contacted.

Table 5-1 Government Officials Contacted with Regards to the Project

Government Agency	Contact
CEA Agency, Atlantic Region	Derek McDonald, Senior Program Officer / and Ian McKay, Program Officer
Transport Canada, Navigable Waters Protection / Environmental Affairs	Jon Prentiss / Oz Smith / Kevin LeBlanc / Jason Flanagan
DFO	Ted Currie, Senior Environmental Analyst
DFO	Vincent Smith, Fishery Officer (Parrsboro area)
CCG Base, Fisheries and Oceans Canada, Saint John, NB	Paul LeBlanc, Officer-in-Charge, Fundy Marine Communications and Traffic Centre
Environment Canada	Adrian MacDonald,/ Monique Breau / Steve Zwicker
Nova Scotia Office of Aboriginal Affairs	Jay Hartling
Nova Scotia Department of Energy	Sandra Farwell
Nova Scotia Department of Natural Resources	Harry Ashcroft
Nova Scotia Department of the Environment	Peter Geddes, Environmental Assessment Officer

5.3 Public and Stakeholder Engagement and Consultation

The engagement of the public stakeholders included a number of components, which are listed below:

Prior to the SEA decision

- Interviews with selected stakeholders and aboriginal groups were held face-to-face or by telephone (February/ March, 2008).

After the SEA decision

- Notification by newspaper at the start of the engagement/consultation process (August 2008);
- Establishment of a focused site on the Minas Basin website (www.minas.ns.ca) devoted to Our Tidal Energy (August 2008);
- The establishment of virtual (e-mail) Stakeholder Liaison Committee and Fishers Contact Committee (July and August, 2008 respectively);
- Public and Stakeholder meetings;
- Correspondence with the relevant mayors and municipal officials in the counties of Kings, Hants, Colchester and Cumberland (July 2008);
- Correspondence (July 2008) and meetings with First Nations and Aboriginal Peoples communities;
- Meetings and telephone discussions with Federal and Nova Scotia Government agencies and departments (ongoing);
- Public Open House and Feedback Session - Parsborro (January 29, 2009);
- Meeting with Fishers (March 27, 2009); and,
- Public Meeting – Wolfville (May 27, 2009).

As noted above, prior to the final SEA decision, the following broad categories of stakeholders with interests in the Minas Passage/Channel area were included in the pre-project engagement process:

- Fishers and clammers;
- Municipal and community officials;
- Tourism organizations and business owners;
- Naturalists and environmental non-governmental organization;
- Local historians/heritage experts; and
- First Nations (on-reserve) and Aboriginal (off-reserve) groups.

In total, 25 stakeholders and Aboriginal Peoples representatives were interviewed between February and March of 2008.

Two overarching community themes were identified in the scoping phase interviews: (1) Do not exploit Parrsboro's natural resources without providing for its people; and (2) Create local ownership of tidal power. These concerns appear to be linked more to the future commercialization aspects of tidal power development than to the operation of the Demonstration Facility.

After the Ministerial announcement regarding the SEA in June 2008, the engagement process officially started with a newspaper announcement by Minas Basin Pulp and Power (prior to the formation of FORCE) inviting the public to become involved in the process. The announcement is included in Appendix 11 of this document, with a list of newspapers in which it appeared during the last weeks in August 2008.

A number of meetings and discussions with public stakeholders and government agencies were held to provide updates on the Project, seek input on issues and concerns and discuss relevant issues with regulatory agencies. The list of these activities is provided in Table 5-2.

Table 5-2 Public and Government Engagement and Consultation

Date	Type of Meeting	Location	Purpose
June 16, 2008	Consultation with DFO	Dartmouth, NS	Project Update and discussion on regulatory

Date	Type of Meeting	Location	Purpose
			issues
24 July 2008	Public Meeting	Canadian Legion, Parrsboro, NS	Project Update and Progress Report, Q&A session
18 September 2008	Formal Presentation	Dartmouth, NS	Presentation of Draft Project Description to federal and Nova Scotia Departments and agencies
01 October 2008	Consultation with Transport Canada	Dartmouth, NS	Project Update, NWPA Permit
01 October 2008	Consultation with NS DNR	Halifax, NS	Project Update, initial discussion re Crown Application
22 October 2008	Public Meeting	Hantsport, NS	Project Update
04 December 2008	Consultation with NS Environment	Halifax, NS	Project Update
12 January 2009	Stakeholder Meeting	Fundy Geological Museum, Parrsboro	Project Update Issues and concerns Input on broader public consultation venue
13 January 2009	Stakeholder Meeting	Acadia University, Wolfville, NS	Project Update Issues and concerns Input on broader consultation approach
16 January 2009	Consultation with NS Dept of Natural Resources	NS Dept of Natural Resources, Truro, NS	Project Update and discussion regarding Crown Lease Application
20 January 2009	Consultation with NS Energy, NS OAA and NSDNR	Halifax, NS	Project Update and MEKS Discussion
22 January 2009	Presentation and Discussion regarding Monitoring	Bedford Institute of Oceanography, Dartmouth, NS	Project Update and specific discussions regarding monitoring approaches with DFO
29 January 2009	Public Open House/Feedback Session	Canadian Legion, Parrsboro, NS	Poster session Formal presentation including project update, technical studies and introduction of VECs
27 March 2009	Consultation with Fishers	Truro, NS	Project Update with

Date	Type of Meeting	Location	Purpose
	on Exclusion Areas		specific focus on commercial fisheries and proposed exclusion areas
27 May 2009	Public Meeting	Wolfville, NS	Project Update

The culmination of the general public and community engagement was the Open House and Feedback Session which was held in Parrsboro on January 29, 2009. The notification for the January 29th event was provided as follows:

- Public announcement (Appendix 11) in the following newspapers- The Citizen (Parrsboro area) and the The Advertiser (Wolfville area) several days prior to the event;
- Posters (Appendix 11) were displayed in Parrsboro and Wolfville, plus other communities in the Kings, Hants and Cumberland Counties;
- Email notification was provided to the Stakeholder Liaison Committee and Fishers Contact Committee, plus additional stakeholders;
- Posted notification on the Minas Basin Website;
- Posted notification on the OEER Website; and
- Radio announcements two days prior and the day of the Open House on the Parrsboro Community Radio 99 FM.

The Open House and Feedback Session was composed of a poster session and formal presentations and Questions and Answers. The Poster Session provided detailed information to the community on all aspects and studies associated with the Project, and gave the public an opportunity to ask questions directly of the scientists and consultants that had completed the work.

The second part of January 29th event were formal presentations providing an update on the Project, summaries of the scientific studies particularly those related to the environment, and an introduction to the proposed VECs.

Participants were provided with comment sheets to be submitted at the Open House/Feedback Session or submitted to AECOM by February 16, 2009. Only three written comments form were submitted at the event and one e-mail was submitted after the Open House/Feedback Session.

The Open House/Feedback Session was well attended, with approximately 90 people participating.

A summary of the key issues and concerns identified at the meetings and open house/feedback sessions with the public and other stakeholders, and engagement with the Aboriginal Peoples are presented in Table 5-3. It should be noted that during the public discussions, many of the issues / concerns were associated with the potential future commercialization of the TISEC technologies. As a result, there was an ongoing challenge to separate the two different levels of concerns between the “Demonstration” Project and potential future commercialization activities.

MBP&P was complimented through-out the process by the public and the Aboriginal Peoples’ groups, from the pre-project engagement in February – March, 2008, to the Open House and Feedback Session on January 29 2009, for their proactive approach in engaging and providing timely and detailed Project information.

In response to fishers' concerns regarding Exclusion Zones around the Demonstration site, a meeting was held on March 27, 2009 in Truro, NS with potentially affected fishers. The objective of the meeting was to describe the proposed exclusion area and listen to their issues and concerns. The meeting was attended by approximately 25 fishers, mainly representing lobster and herring weir fishing. The meeting set out a procedure for future contact and follow-up with fishers to minimize impacts and interference with the commercial fisheries, particularly lobster, in the area. Further meetings and discussions are required and will be held with a more focused group of fishers over the coming months.

Table 5-3 Key Issues and Concerns Raised by the Public and FN/ Aboriginal Peoples

Main Topic	Concern/Issues	Study Team Response/Section in EA Document
Project	• Why is the NS Power turbine being deployed early? • Will more than 3 turbines be deployed at this site?	• NS Power is an experimental deployment to test deployment methods and monitoring strategies • This Project only deals with the deployment of 3 turbines; any future decision for more turbines would be addressed by a new EA process
Noise & Vibration – Marine	• Impacts on fish and mammal behaviour • Migratory patterns.	• Section 6.2 (Fish) and 6.3 (Mammals)
Chemical Contamination	• Impact on fish and mammals from the release of lubricants and anti-fouling paints from turbines	• Section 6.2
Seabirds	• Direct impacts of turbine on the seabird populations • Impacts on activities of sea birds	• Section 6.4
Electromagnetic Fields (EMF)	• Impacts on behaviour of fish and marine mammals	• Section 6.2, 6.3
Broad Ecosystem Concerns	• Removable of kinetic energy and impact on sediment transport • Impact on biological activity in the Bay, *i.e.,* the "domino effect"	• Section 6.2 • Sections 6.1 & 6.2
Species at Risk	• Impact on Inner Bay of Fundy Atlantic Salmon and Striped Bass, *i.e.,* strikes, disruption migratory patterns • Impact on marine mammals such as porpoises, *i.e.,* strikes	• Section 6.5 • Section 6.3
Transportation	• Marine transportation, shipping, fishing and recreational activities • Upgrade to West Bay Road, *i.e.,* paving	• Section 3.4.8 • The upgrading of West Bay Road is not part of this Project, unable to comment further

Ice	• Impact of ice flows on the turbines • Thickness of the ice	• Section 3.2.3
Currents/Eddies	• Eddies and gyros off Cape Sharp, how will this affect the project?	• No gyros/eddies were identified in the demonstration area. Project not affected by Cape Sharp eddies
Climate Change and Earthquakes	• Impact of sea level rise and storm surges on the project. • How stable is the area in terms of earthquakes?	• Section 9 • Section 9
Recreational and Tourism	• Impact of landfall site on beach access/use • Tourism opportunities • Location of onshore interpretive centre – West Bay versus Parrsboro	• No interference with beach access identified by public or tourist operators • Section 6.11 • Section 6.11
Local Economy	• Employment opportunities • Upgrade to Parrsboro Wharf, *i.e.,* will there be maintenance activities for turbines from Parrsboro • Educational opportunities for youth related to new technologies	• Sections 3.3.4-3.3.7 • Tentative responses provided during open house sessions • Parrsboro harbour may not be suitable for large vessel mobilization
Visual Impacts/Aesthetics	• Visual impact of upgraded transmission line from West Bay to Parrsboro, *i.e.,* large towers	• Not an issue, since upgraded transmission line will not use large towers, but standard power poles
Commercial Fisheries	• Impact on lobster fishery in the area-displacement of fishers • Impacts on spawning of fish • Impact on migratory patterns of lobster • Size of exclusion zone for lobster fishery • Timely communication with fishers when monitoring, construction and maintenance activities in the marine area • Impacts on other fisheries	• Section 6.9 • Section 6.2 • Section 6.9 • Section 6.9 • Section 6.9 • Section 6.9
Use by Aboriginal Peoples	• Impact on archaeological and cultural resources • Impact on food, social and ceremonial activities for plants, wildlife fish and shellfish • Will a MEKS be done?	• Section 6.10 • Section 6.10 • Yes, a MEKS was initiated in March 2009, in cooperation with the Province of NS

Monitoring	• Will the NS Power turbine be monitored before hooked to the cable? • How will the devices be monitored, *i.e.,* cameras • Public would like to be kept informed, *i.e.,* ongoing liaison/monitoring committee	• Section 2.4 • Section 2.4 and elsewhere • Project developments posted on Minas Basin website
Commercialization	• How many turbines will be in the commercial array • When will commercial array • Royalties and rate structure for commercial array • Keeping benefits in local area and Nova Scotia	• Beyond the scope of this Project

5.4 Engagement of Aboriginal Peoples

5.4.1 Communication and Meetings

During the pre-project engagement activities, selected First Nations and Aboriginal groups were contacted for the Demonstration Facility's EA scoping phase outreach. Two First Nations (Fort Folly First Nation in New Brunswick, and Millbrook First Nation in Nova Scotia) and one Aboriginal group (the Native Council of Nova Scotia - NCNS) were contacted by AECOM. Of these three groups contacted, only Fort Folly First Nation and the NCNS requested follow-up interviews.

In addition, meetings and/or telephone discussions were held with the individuals noted below beginning in February 2008, including:

- Twila Gaudet, KMK (Mi'Kmaq Rights Negotiation), Assembly of Nova Scotia Mi'kmaq Chiefs;
- Roger Hunka, Director of Aboriginal Intergovernmental Affairs, Maritime Aboriginal Peoples Council (Native Council of Nova Scotia); and
- Chief Joseph Knockwood, Chief, Fort Folly First Nation, New Brunswick (and subsequently, Stuart Gilby of Burchells Law Firm).

In mid-July 2008, the thirteen Mi'Kmaq Chiefs of Nova Scotia and Chief Knockwood of Fort Folly FN in New Brunswick were contacted by letter offering individual briefings and/ or a collective workshop to learn more about the Project and provide feedback regarding their questions or concerns about the Project. A similar letter was sent to Chief Conrad of the Native Council of Nova Scotia offering to meet with the Council to discuss and update them on the Project.

In addition to ongoing telephone discussions with KMK, formal presentations were provided to the Assembly of the Nova Scotia Mi'kmaq Chiefs, Stuart Gilby of Burchells Hayman Parish (representing the Fort Folly First Nation, New Brunswick), and the Native Council of Nova Scotia as indicated in Table 5-4.

In January 2009, the final Project Description (submitted to CEAA in late December 2008) was also provided to the KMK, the NCNS and Burchell Hayman Parish. This is not required and normally the Project Description is distributed by the federal RAs, but this was considered to be an important element in engaging the Aboriginal Peoples having interest in the Project.

Table 5-4 Engagement Meetings with Aboriginal Peoples

Date	Type of Meeting	Location	Purpose
02 October 2008	Formal Presentation to Burchell Law Firm representing Fort Folly First Nations, New Brunswick	Halifax, NS	Project description, identification of issues and concerns
14 November 2008	Formal Presentation to the Assembly of Nova Scotia Mi'kmaq Chiefs	Dartmouth, NS	Project description, identification of issues and concerns
26 January 2009	Discussion with NS Energy, NS OAA, NS Environment and KMK	Halifax, NS	Project Update and scoping session
27 February 2009	Formal Presentation to the Native Council of Nova Scotia (NCNS)	NCNS Office, Truro, NS	Project update and identification of issues and concerns

5.4.2 Mi'kmaq Ecological Knowledge Study (MEKS)

A Mi'Kmaq Ecological Knowledge study (MEKS) for the Minas Channel/Basin was initiated in late March 2009. This Project is being led by the Province of Nova Scotia and co-funded by FORCE as part of a broader and longer term MEKS for ocean renewable energy for the Bay of Fundy.

The MEKS will be undertaken to:

- Identify and consider Mi'kmaq use of the land and resources and Mi'kmaq ecological knowledge;
- Gather and document the collective body of ecological knowledge held by the Mi'kmaq ecological; and,
- Provide assurances that the Mi'kmaq use and knowledge of the Project area and its resources are considered within the overall environmental assessment.

The expected completion date for the MEKS study is August 2009.

5.5 Ongoing Engagement During Project Implementation

FORCE is committed to the ongoing engagement and consultation with the public and Aboriginal People during further Project development, implementation and operation. The existing Public Liaison Group will be continued to ensure there is a mechanism in place for updating the public on all Project activities and a forum for sharing environmental monitoring information and data as it becomes available. This Group will also be used to identify other consultation activities in response public interest for the Project.

As noted in Section 5.2, the Fishers Contact Committee will be used to keep area fishers updated on the Project activities to minimize any impact on commercial fisheries in the Project Demonstration area.

There will continue to be ongoing communication with Aboriginal Peoples communities as the Project proceeds to ensure they are involved and aware of Project activities that may be of interest.

The Minas Basin website, which is available to all stakeholders will be updated on a regular basis as the Project develops.

The proposed Interpretive Centre (as it is developed in the future) at the landfall site will a mechanism to keep the broader public aware of the Project and provide tourist information for the Project. Linkages with to the Fundy Geological Museum and Joggins Centre will be investigated. As well, because of the very nature of the Project as a demonstration of new renewable energy technologies, there will be an ongoing local and external interest, including academia and governments, resulting in the opportunities for future technical and scientific workshops and meetings.

6. Environmental Effects Assessment

6.1 Marine Benthos

Marine benthos is retained as a VEC in consideration of the potential environmental effects of Project-related activities on existing benthic communities and marine sediments in the Minas Passage. Marine benthos includes all of those organisms which are associated with substrates, either the seabed or solid structures sitting upon the seabed (*e.g.,* TISEC devices). Plants in benthic communities stabilize marine sediments, provide shelter and act as a food source to the marine ecosystem. Animals of benthic communities are herbivores making up a significant portion of the marine food web, are prey for carnivorous pelagic and demersal fish species, and contribute to marine nutrient cycling. The benthic fauna category includes species which are stationary as well as numerous species that are mobile, but stay very close to the surface of the substrate rather than moving in the water column. This group of epibenthic animals includes a number of invertebrates, notably scallops, lobster, crab and a variety of shrimp-like crustaceans, as well as demersal fish, discussed separately in Marine Fish and Water Quality (Section 6.2).

Since marine benthos are associated with substrates and benthic organisms live and interact directly in or on sediments, changes to the quality of marine sediments can have a direct impact on the health of benthic communities, either through physical interactions (behavioral effects, habitat loss, changes in prey abundance or distribution) or chemical interactions (uptake of nutrients and toxins). Changes in sediment quality can therefore result in changes to benthic communities, which in turn can affect higher trophic levels in the marine food web (*e.g.,* marine fish, mammals, birds). The assessment of Marine Benthos is therefore closely linked to the assessment of Marine Fish and Water Quality (Section 6.2), Marine Mammals (Section 6.3), and Marine Birds (Section 6.4).

6.1.1 Boundaries

The spatial boundaries for the assessment of marine benthos include the Minas Passage/Minas Channel and the Minas Basin. Marine benthos in the Minas Basin are also described in Section 3.2.5; however, Project activities are limited to within Minas Passage. The spatial boundaries also include the zone of influence from any sediment plumes associated with Project activities that disturb the seafloor (*e.g.,* TISEC device installation) and changes to sediment dynamics resulting from energy conversion. Conservatively, then, the spatial boundary for this component of the EA encompasses all of the Minas Passage/Minas Channel and the Minas Basin.

The temporal boundaries for the assessment of marine benthos include the construction, operation and decommissioning phases of the Project. The temporal scope also includes the recovery time for benthic communities that are affected by Project activities, and the period of sediment re-suspension and subsequent return to baseline water quality conditions once construction and decommissioning are complete.

Marine benthos is a component of fish habitat. Any Project activities that could affect the marine benthos are subject to regulations under the federal *Fisheries Act*. Federal policy for the Management of Fish Habitat applies to all projects with potential to alter, destroy or disrupt fish habitat.

The analysis of marine benthic quality was based on a review of existing knowledge for the study area as well as a video survey of the benthic environment in the Minas Basin, habitat and sediment chemistry sampling program, and any limitations therein (Appendix 4). Benthic videos and sediment sampling may provide a general picture of existing conditions; however, they do not provide comprehensive data for the entire seabed. The ability to predict environmental effects with a high level of confidence is limited by the nature of these surveys.

6.1.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on marine benthos is defined as a physical, chemical, or biological alteration of benthos, in quality or extent, to such a degree that there is a decline in abundance and/or change in distribution of benthos, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return that population, within a generation or more, to its former level. Such a change could result in alterations in sediment nutrient cycling, community structural complexity, biotic interactions, habitat pattern, population dynamics and ultimately genetic diversity,

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on marine benthos is defined as an enhancement in benthic quality, increase the species diversity, or increase the area of the valued benthic habitat.

6.1.3 Potential Issues, Interactions and Concerns

Very little is known about the Marine Benthos of the Minas Passage area, however, when compared with coastal estuaries, the sediments are relatively uncontaminated (Chou *et al.* 2004). A number of Project-related activities (*i.e.,* installation of turbines and cables, turbine operation) have the potential to affect marine benthos. Installation and decommissioning represent the most important interactions between the Project and marine benthos, however, all phases of the Project could disturb the benthic communities and sediments in the Project area, leading to potential effects such as direct injury or mortality of slow-moving or immobile benthic flora and fauna, destruction or modification of benthic habitat, vibration effects, and indirect effects through changes in patterns of sediment distribution. As a result of these potential environmental effects to benthic habitat, the proposed Project may constitute a habitat alteration, disruption or destruction (HADD) under the *Fisheries Act*.

Installation and decommissioning of Project infrastructure in the marine environment may result in the limited direct mortality of some slow-moving or immobile benthic flora and fauna and the permanent alteration of a small area of benthic habitat in the immediate Project footprint (*i.e.,* the Gravity Based Structures will cover pre-existing habitat). Benthic communities have been shown to recover from disturbance related to other types of marine construction activities (*e.g*., dredging) (Dernie *et al*. 2003); as such, it is expected that once construction/decommissioning activities are complete, benthic species will re-colonize the area. The amount of benthic habitat lost to Project infrastructure will be minimal (due to the small size of the Project footprint, approximately 0.31 ha for three TISEC devices and subsea cable) in relation to the area of available habitat in the Minas Passage or the Minas Basin as a whole. Additionally, there is no information to suggest that the area of the Passage in the vicinity of the proposed Demonstration Facility represents key habitat in which rare or sensitive benthic species are present.

These activities may also cause the temporary degradation of habitat (water) quality through an increase in turbidity in the water column resulting from disturbance to the seabed. While suspended sediments play an important role in the marine environment, particularly for benthic organisms, high levels in the water column can decrease habitat quality (Park 2007), for example, there is generally a lower amount of dissolved oxygen associated with high suspended sediments values (Ntengwe 2006). It is expected that while benthic organisms may face some temporary disturbance to the use of their habitat due to suspended sediments, these effects will be short-lived; returning to baseline levels following the completion of installation or decommissioning activities, and they are not expected to result in mortality or long-term alterations.

Turbine operation could potentially result in changes to the patterns of sediment distribution, which in turn may have an environmental effect on marine benthos. Although usually immobile as adults and therefore not likely to be directly affected through impact with the turbines, many benthic organisms are adapted to and critically dependent upon particular substrates; the distribution and properties of which might be altered by the proposed Project. Reductions in current velocity affect the transportation and deposition of sediments; sediment properties affect the benthic organisms that inhabit them, and consequently the fish and other species that feed upon them. Any effects of marine energy devices that diminish the productivity or diversity of the benthic community may exert indirect effects upon the fish populations that depend upon the existing benthic community.

6.1.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Installation and decommissioning of the turbine devices and cables (including drilling for the MCT turbine, if required) will inevitably affect the seabed and will create a direct adverse impact with respect to seabed disturbance. Installation and decommissioning activities will disturb benthic species in the area, potentially resulting in limited direct mortality or injury of slow-moving or immobile benthic flora and fauna. Due to the limited species diversity and low population densities of marine benthic communities in the deployment area, as well as the absence of key habitat in which rare or sensitive benthic species are likely to be present, the loss of a limited number of individuals is unlikely to cause long-term changes at the population level as their ubiquitous population throughout the Passage will suffice to re-colonize the new substrate.

Installation of the turbine devices and cables may result in the permanent alteration of a small area of benthic habitat in the vicinity of the Project footprint, at the very least Project components will cover pre-existing habitat. Some seaweeds (small rockweeds) would be dislodged in the shallows and in deep water presumably some encrusting animals such as sponges and anemones, and surface dwelling fauna (amphipods, sea stars, and polychaete worms) would be displaced from the bottom. Impacts of this nature are likely to be localized and temporary, with short-term recovery. This loss will be minor as the Project footprint will largely occur on scoured bedrock with very limited habitat potential and the turbine devices and the cables themselves have small individual footprints. It is anticipated that once turbine devices and cabling have been secured to or removed from the seabed, species will re-colonize disturbed areas, however, how long that would take is not known. In the shallow water nearshore where currents are less severe, re-colonization by seaweeds and other organisms would likely be typical for coastal areas (*i.e.,* within a couple of seasons). Seaweeds would begin to re-colonize the first year after construction and grow out to maturity in subsequent years. The high currents in deeper water make conditions for re-colonization of seabed rock surfaces inhospitable, which is the reason that existing benthic communities in the area display limited species diversity and low population densities (Appendix 4: Envirosphere 2009a). The benthic habitat that will be directly affected by construction activities is not critical habitat for the marine organisms of the Project area. Nevertheless, recovery success depends upon the type of disturbance, sediment properties, species tolerance and the ability of species to re-colonize through adult mobility and larval settlement (Jones 1974). Marine temperate water boreal species may require two to three years to re-colonize a disturbed area (Scarratt 1968). It is unlikely that installation of turbine devices and cables will result in a measureable reduction of community diversity on a basin-wide basis. Although construction activities will impact the existing epibenthos in the Project footprint, its magnitude and duration are such that it is not predicted to present a long lasting interaction on the nature, structure and function of the communities within the area as a whole.

Project related drill cutting dispersion/deposition may result in the smothering of habitat within the potential zone of influence of sediment plumes, should drilling for turbine foundations be selected as the preferred method for MCT installation. This loss will be minor as the Project footprint will largely occur on scoured bedrock with very limited habitat potential. In the event that drilling is required, typical procedures will be followed and a reverse uplift rock drill will be utilized in order to minimize the amount of cuttings deposited on the seabed. The geographic extent of such impacts is anticipated to be minimal in relation to the area of available habitat in the Minas Passage or the Minas Basin as a whole. It is anticipated that once the construction phase of the Project is complete, species will re-colonize disturbed areas; however, how long that would take is not known (as above).

Fixed and moored structures typically become a focus for marine production (*e.g.,* reef effect) which further attracts marine life, including fish. In some cases, structures can provide alternate habitat for marine benthos, the effect of which may even be considered beneficial if these structures provide habitat diversity which may in turn increase benthic species diversity in the area. Given that the turbine devices and their GBSs or foundations will be coated with an anti-fouling coating prior to deployment, this effect would be minimized. Furthermore, given the high current velocities in the Project area, this effect is rendered unlikely.

Due to the water depth, there will be limited opportunity for sediment disturbance from vessel prop wash. However, construction and decommissioning activities associated with the proposed Project will disrupt the seabed and will tend to remobilize sediments that are present on site, creating plumes that will travel away from the site for varying distances. Activities associated with construction and decommissioning of the proposed Demonstration Facility are expected to be of short duration (*i.e.,* days) and intermittent given the proposed schedule. Given the high current velocities in the Project area it is expected that any sediment plumes will quickly dissipate from the immediate area (within part of a tidal cycle). These plumes are likely to be limited in magnitude since the Project footprint will largely occur on scoured bedrock (Appendix 4: Envirosphere 2009a). As such, although elevated suspended solid concentrations from construction and decommissioning activities may cause temporary changes to marine water quality and thus marine benthic habitat quality, particularly in the event that drilling is selected as the preferred option for MCT installation, it is unlikely that levels would increase to such an extent that changes would be detrimental. There will not be any long-term effects and changes in suspended solid concentrations will be negligible (Appendix 4: Envirosphere 2009a).

There are two main sources of vibration and noise within the context of the proposed Demonstration Project. The first is through installation and decommissioning which may include vibration and noise from turbine device and cable construction and the presence of boats and other equipment (*e.g.,* vessel engines, vessel ancillary equipment) (CREST Energy Limited 2006). Of the proposed device owners, OpenHydro is the only device for which noise information is available, as the device holder carried out testing at a potential tidal energy project, the European Marine Energy Centre (EMEC) in the Orkney Islands in Scotland. Measurements were taken at ranges from 50 m to 790 m and were found to exhibit broadband (1 Hz to 120 kHz) Sound Pressure Levels from 140 to 110 dB (re 1μPa) respectively. Based on these readings, the Source Level noise at 1 m is expected to be 162 dB (re 1μPa).

The second source of noise and vibration concerns the possible vibration and noise emissions from the vessel and equipment (CREST Energy Limited 2006). It has been reported by Richardson *et al.* (1995) that typical vessel traffic (*e.g.,* barges, tugs and bulk carriers) generally produce sound levels between 168 and 193 dB (1 μPa) at 1 m distance. Large vessels required during installation and decommissioning will be limited in number and duration of use. Support vessels used during construction and decommissioning and vessel requirements during operation will generally be small in size and limited in numbers. Excessive vibration may cause direct effects to the seabed, including liquefaction, increasing turbidity and the disruption of benthic communities. These possible effects are dependent on the type of seabed and sediment characteristics. No significant adverse impacts from vibration are expected in the area of the Demonstration Facility, given the nature of the seabed in the area (scoured bedrock) and the limited magnitude of vibration resulting from Project activities. However, given the virtual lack of published data related to marine turbine operations, noise monitoring during operation of the turbines is recommended and species specific studies be undertaken.

During operation of the proposed Demonstration Facility, there is the potential for re-suspension of sediments (habitat degradation/disruption), as well as the redistribution of sediments resulting from reductions in the kinetic energy of the water that has passed through turbine devices. The Project footprint will largely occur on scoured bedrock such that it is unlikely that suspended sediment levels would increase to any significant extent during Project operations because there are no fine sediments to be mobilized (Appendix 4: Envirosphere 2009a). There will not be any long-term effects on habitat quality.

Turbine operation could potentially result in changes to the patterns of sediment distribution, which in turn may have an environmental effect on marine fish and invertebrates; however, this issue is not well understood. If a significant fraction of the kinetic energy is removed (*i.e.,* commercial scale tidal facility), the overall effect in Minas Basin may include reduction in turbulent mixing, changed patterns of current movement within the Basin, and hence changed patterns of sediment distribution. Deposition characteristics outside the natural variability of an area will cause changes to the water column and, in turn, water quality. Such deposition may also cause changes to the local seabed, sediment dynamics and ecology of the area. Sediment properties affect the benthic organisms that inhabit them, and consequently the fish and other species that feed upon them. The distribution and abundance of marine fish species are largely a function of sediment properties, which could potentially be changed as a consequence of tidal power development. Effects associated with loss of energy from water flows in the Passage and subsequent impact on sediment deposition will be negligible based on the relative scale of the Demonstration Project and the scale of tidal flow and energy in the Minas Basin (Jacques Whitford *et al.* 2008).

Additionally, the presence of a structure in the marine environment on its own may result in effects on current velocity in the immediate vicinity of the structure. When a structure is placed on the seabed, the flow is disturbed locally around the structure. In areas where the seabed is comprised of cohesionless surface deposits (silt, mud, sand gravel and weak clays), the accelerated flow around the structure may scour away the seabed around the base of the structure, including benthic and underlying surface deposits, and these deposits can later fall back out of suspension further downstream (CREST Energy Limited 2006). These changes may result in changes to the ecology of the area. The Demonstration Facility will be located in an area of scoured bedrock seabed and thus such effects are not anticipated.

As per the SEA and the Background Report, it is acknowledged that a demonstration scale project will not likely have any measurable effects on physical processes beyond the immediate area (OEER 2008), such that any effects on marine benthos resulting from changes in sediment distribution are not likely to be significant. Adverse effects in terms of surface turbulence, seabed erosion and their potential effects on benthic organisms resulting from the presence of the turbine deceives are not anticipated as a consequence of the location being in an area of scoured bedrock seabed. Effects associated with loss of energy from water flows in the Passage and subsequent impact on sediment deposition are not anticipated based on the relative scale of the Demonstration Project and the scale of tidal flow and energy in the Minas Basin.

Monitoring of sediment concentrations and grain size in the water column will be undertaken prior to deployment of the turbines, and will continue to be collected during turbine operation in order to further understand the implications of TISEC development on the commercial scale. In addition, developing an adequate model of the dispersion and settlement of sediments during TISEC operation will require investigations of sediment distributions over areas that might be influenced by reductions in current velocity.

It is understood that HADD Authorizations will be required for this Project. It is anticipated that each of the device owners will obtain an authorization to permit deployment and negotiate compensation for the loss or disruption of fish habitat associated with each of the individual devices. Also, FORCE will obtain an authorization to permit cable installation and negotiate compensation for the loss or disruption of habitat associated with the cables. FORCE and the device owners will work with DFO to establish the appropriate footprints for which habitat compensation will be based, to offset any residual effects associated with the individual components as well as to identify opportunities in the region for fish habitat improvement projects. Compensation plans will involve planning, implementation and monitoring components and will include stakeholder consultation, as needed.

6.1.5 Follow-up and Monitoring

The response of marine benthos to TISEC devices is currently unknown, and this is a critical gap in knowledge. If a significant fraction of the kinetic energy is removed (*i.e.,* commercialization), the overall effect in Minas Basin would be some reduction in turbulent mixing, changed patterns of current movement within the Basin, and hence changed patterns of sediment distribution. It is essential to know how currents and therefore sediments and marine benthos behave in the vicinity of each turbine device in order to forecast (model) the effects of commercial development. This is a key requirement for research and monitoring at any demonstration site. Because of the varied TISEC designs, such research will be needed for each case.

FORCE and the device owners will implement a detailed monitoring program for the Demonstration Facility. The details of the program will be developed in consultation with federal and provincial regulatory agencies and incorporated into the Environmental Management Plan for the Project. This monitoring information will be used to confirm the predictions made in this assessment and to further inform future commercial developers through modelling.

Changes in sediment distribution potentially resulting from the installation and operation of turbine devices may result in changes to invertebrate populations, which in turn may have effects on marine organisms and consequently the fish and other species that feed upon them. An objective of the Demonstration Facility is to gather information that will serve to further evaluate the potential effect for a larger scale development. The monitoring program will include monitoring of currents around turbines (including a control point) and other related aspects, including video surveys for changes in sediment deposition, if and where possible.

Historically, significant changes have taken place in the Upper Bay of Fundy (*e.g.,* causeway construction and changes in fishery stocks); however, consequences of these changes for the benthic community often take decades to be revealed (Daborn *et al.* 1995). Monitoring of the benthic community and habitat characteristics needs to be repeatedly surveyed for a number years following installation of devices. Standard monitoring transects should be laid out in areas that are thought to be within the area of influence of the development, together with reference transects that are well outside that zone in order that effects on the benthic community associated with long-term natural cycles or other ecosystem changes can be distinguished from those resulting from the energy development itself.

In addition to monitoring proposed above, noise monitoring for the proposed Project is anticipated to include:

- Collection of ambient noise levels in the area of the turbine devices;
- Collection of noise data for each of the turbines during regular operation; and
- Collection of noise data at a control point established so as to capture cumulative noise emissions from the three devices.

The above information will be used to confirm the predictions made in this assessment related to the environmental effects of turbine vibration emissions on the seabed and marine benthos. It will also be used to model the potential cumulative noise emissions for potential future commercial tidal energy developments.

6.1.6 Summary of Residual Environmental Effects Assessment

The fundamental knowledge required to assess the environmental effects of TISEC on currents and therefore sediments and marine benthos does not currently exist; consequently, building the research knowledge base among the scientific community of the Bay of Fundy represents a valuable asset that will amplify the potential for the Maritime region to become a global centre of excellence in marine energy developments (Jacques Whitford *et al.* 2008). It is acknowledged that there is a degree of environmental risk involved in Project development that cannot be completely eliminated due to this lack of knowledge. Monitoring and follow-up, described previously, will be an integral part of confirming the predictions of this assessment, informing future commercial developers and will provide opportunities for further research on the Minas Passage, the Project and potential interactions.

By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine benthos within the Project area or vicinity (*i.e.,* Minas Passage and Minas Basin).

Cumulative effects are assessed in Section 8.0 and accidental events are assessed in Section 7.0.

6.2 Marine Fish and Water Quality

Marine Fish and Water Quality is retained as a VEC in consideration of the potential environmental effects of Project components and activities on fish in Minas Passage and the water column in which they reside. Environmental effects on marine fish may indirectly affect other ecosystem components that reply on marine fish as a food source, in addition to commercial and non-commercial fisheries. This VEC was selected to meet specific regulatory requirements under the *Fisheries Act* and due to the important role that fish populations have on the marine ecosystem and on the stability of fisheries resources.

The assessment of Project environmental effects on Marine Benthos and Marine Mammals are discussed separately in Sections 6.1 and 6.3 respectively. Environmental effects on Recreational and Commercial Fisheries are assessed separately in Section 6.9. Environmental effects to fish species that depend primarily on water bodies located in terrestrial habitats have been assessed in Section 6.6, Intertidal Environment. Project effects on marine fish considered to be at risk are considered separately in Section 6.5, Marine Species at Risk.

According to the federal *Fisheries Act*, “fish” includes all fish, shellfish, crustaceans, marine animals (including juvenile stages), or parts thereof, as well as the eggs, sperm, spawn, larvae or spat. “Fish habitat” includes food supply and migration areas on which fish either directly or indirectly depend, as well as spawning, nursery and rearing grounds. Fish habitat also includes biological, physical and chemical attributes. Examples of biological attributes may include populations of aquatic plants, plankton and benthic invertebrates. Physical attributes including substrate, temperature, flow velocity, flow volumes and water depth are also components of fish habitat. Finally, chemical attributes of fish habitat include pH, nutrients and dissolved oxygen. For the purposes of this Project, water quality will be assessed based on changes to suspended sediment levels in the water column of the study area, rather than (for example) metal concentrations or changes to salinity.

6.2.1 Boundaries

Interactions between Marine Fish and Water Quality and the proposed Project are limited to the Minas Passage, the proposed site of the Demonstration Facility. These interactions may occur at any time of the year, though different species and life cycle components vary seasonally while juveniles and adults of those same species are present year round. Information regarding existing marine fish and marine water quality is described in Sections 3.2.6 and 3.2.4, respectively.

The majority of the fish species in the Minas Passage are migratory, and are typically present only at particular times of the year. These species would be present in the Passage on a seasonal basis (while migrating between foraging habitats and spawning grounds) and none of these species are known to spawn in the Passage in the vicinity of the proposed Demonstration Facility. While marine and salt tolerant species are expected throughout the year, their abundance varies according to many factors including tidal cycles (over small scales) and season (over larger scales). The migratory movements and spawning seasons of fish species found in the Minas Passage are further described in Section 3.2.6 of this report. Due to the large number of species which undergo migrations, collectively there will be limited time during the year when there are no fish moving through the Project area (Jacques Whitford *et al.* 2008).

The temporal boundaries for this assessment include the construction, operation and decommissioning phases of the Project. Accidents, malfunctions and unplanned events, such as spills, may also affect marine fish and water quality, and are assessed separately in Section 7.0 of this report. Temporal boundaries for such events would be dependent upon the nature, duration and magnitude of the accident and its effects. The temporal scope also includes the period of sediment re-suspension and subsequent return to baseline water quality conditions once installation is complete, as well as the times of year when fish species are more likely to be present in the Minas Passage (and Minas Basin) and exposed to Project activities.

Spatial boundaries for the assessment of marine fish are generally determined by the stock boundaries, representing the area within which a population is self-sustaining. The stock boundaries of many species considered in this assessment fall roughly within Unit Area 4XR. Fish, including eggs and larvae, are also distributed spatially within different levels of the water column, ranging from the thin surface layer to the ocean bottom. The spatial boundaries were set to the limits of Unit Area 4XR to ensure that any effects that might be detectable at the "stock" level would be included. The spatial boundary for marine water quality includes the entire water column, and encompasses the potential zone of influence of Project-related sediment plumes associated with Project activities that disturb the seafloor, discharges and potential spills.

Fish and fish habitat are protected under the federal *Fisheries Act* and the Nova Scotia *Environment Act*, while species at risk are protected under the federal *SARA* and the Nova Scotia *Endangered Species Act*. The *Policy for the Management of Fish Habitat*, developed in 1986 by DFO, applies to all projects (development and industrial), large and small, in or near watercourses that could alter, disrupt, or destroy fish habitat by any means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The *Fisheries Act* is administered by DFO (except Section 36 which deals with the control of deleterious substances in fish habitat and is administered by Environment Canada in cooperation with DFO). DFO also works in collaboration with Nova Scotia Environment to protect fish and fish habitat. As a result, all activities that could potentially affect fish and fish habitat must be approved in advance by DFO and Nova Scotia Environment. In certain cases, approval may be required from Environment Canada.

Marine fish within the Minas Passage was described using existing published literature and technical reports, consultation with scientific experts and through independent studies undertaken specifically in support of this Project. At this point, there are insufficient data to state definitively how marine fish will be impacted by small scale tidal power projects; studies in the marine environment are scarce as TISECs represents a new area of development (DFO 2008b). Thus, this assessment takes a precautionary approach to the assessment of impacts, delineates those effects that are not well understood, and identifies areas where further work is required.

6.2.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on Marine Fish and Water Quality is defined as one that creates a significant alteration to a population (or a portion of it) to cause an unnatural decline or change in the abundance or distribution of the population to a level from which recovery of the population is uncertain, over one generation or more. Original population levels may not be re-established by natural recruitment (reproduction and immigration from unaffected areas). A significant population effect on fish habitat may alter the quality or extent of valued habitat physically, chemically, and/ or biologically, such that there is a decline in the species diversity of the habitat. This effect may be demonstrated by a decline in abundance and/or change of habitat components (*i.e.*, sediment quality, food resources, water quality, and riparian vegetation).

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on Marine Fish and Water Quality is defined as an enhancement in the quality or extent of habitat, an increase in species diversity, or an enhancement of a population such that an increase in that population is evident, or such that natural mortality is reduced.

6.2.3 Potential Issues, Interactions and Concerns

A number of Project-related activities have the potential to affect marine fish in the water column and changes to water quality (*i.e.,* installation of turbines and cables, vessel traffic, turbine operation). Potential effects may include destruction or modification of fish habitat, direct injury or mortality caused by interactions with Project components, noise and vibration effects, effects of EMF generated by subsea cables, and indirect effects through changes in prey distribution and abundance. There is limited information related to the behavioural responses of marine fish to TISEC devices and furthermore, there is a relatively low confidence level with respect to the distribution patterns for marine fish in the Project area.

Project activities associated with terrestrial site preparation (*e.g.,* clearing, grubbing and grading) and construction of land-based components (*e.g.,* substation) will not have any significant interactions with the marine environment and the environmental effects on marine fish and water quality is therefore considered to be insignificant and are not considered further in the assessment.

Installation and decommissioning of the turbine devices and cables may result in the permanent alteration of a small area of fish habitat in the vicinity of the Project footprint; at the very least some Project components will cover pre-existing habitat. These phases of the proposed Project could potentially result in limited direct mortality or injury to marine fish, or result in the temporary degradation of habitat (water) quality through an increase in turbidity in the water column resulting from disturbance to the seabed. While suspended sediments play an important role in the marine environment, particularly for benthic organisms, high levels can decrease habitat quality (Park 2007). For example, there is generally a lower amount of dissolved oxygen associated with high suspended sediments values (Ntengwe 2006).

Potential additional permitting requirements (if any) associated with the installation of marine Project components, including habitat compensation, will be evaluated in consultation with relevant regulatory agencies. In any event, the potential habitat loss or disruption associated with the Demonstration Facility will be minimal (due to the small size of the Project footprint) in relation to the area of available habitat in the Minas Passage or the Minas Basin as a whole. Additionally, there is no information to suggest that the area of the Passage in the vicinity of the proposed Demonstration Facility represents key habitat in which fish species are known to spawn.

Noise and vibration associated with the installation and decommissioning phases of the Project may result in effects on marine fish in the Project area; however, the importance of such effects, particularly with regard to migratory species, currently are not well understood. Installation of the MCT turbine may involve drilling for the installation of the foundation structure which would also result in temporary and localized increased noise and vibration, as well as increased turbidity levels which have the potential to interact with marine fish through habitat (water) quality degradation. Increased noise (magnitude, frequency, duration and character) above background levels resulting from construction or decommissioning (including increased vessel traffic), may result in short or long-term changes to behaviour and habitat use, injury or mortality of marine fish. Once the construction and decommissioning phases of the Demonstration Facility are complete, the disruption to marine fish will be related primarily to noise and vibration produced by turbine operations. Minas Passage has traditionally been utilized by marine vessels, such that noise levels produced by the construction and decommissioning phases of the Project will not be abnormal when compared to background noise levels in the Passage.

The Project will involve the use of large barges and vessels during the construction phase for the deployment of the turbines and installation of the cables. Project related vessels used in all Project phases could result in increased noise levels which may cause fish to exhibit localized temporary avoidance behaviour in the area of the vessels. Vessel traffic will be limited during the operations phase to small and medium sized vessels (*e.g.,* fishing vessels) used for various monitoring programs. Vessel traffic during decommissioning is expected to be similar to the construction phase.

While construction activities will occur intermittently at different locations (*i.e.*, turbine berths and along the cable corridor), turbine operations will be continuous in subsequent years; therefore interactions (*e.g.,* fish strikes, noise and vibration, EMF effects) between Project components and marine fish could occur at any time during the life of the Project. Operation of the Demonstration Facility could potentially have indirect effects on marine fish through changes in prey distribution and abundance. The distribution and abundance of marine prey species are largely a function of sediment properties, which could potentially be changed as a consequence of tidal power development (Jacques Whitford *et al.* 2008). There is llimited information available regarding behavioural responses of marine fish to TISEC devices and the importance of potential effects, particularly with regard to migratory fish species, is currently not well understood.

6.2.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Construction/ Decommissioning

Installation and decommissioning of the turbine devices and cables (including drilling for the MCT turbine, if required) will inevitably affect the seabed and will create direct adverse impact with respect to seabed disturbance. However, such impacts will be temporary and localized to the area immediately around the turbines and cables. Installation and decommissioning activities will disturb species in the area, potentially resulting in limited direct mortality or injury to marine fish (including eggs/larvae), especially in seabed communities.

Most adult pelagic and demersal fish species will likely avoid such activities due to the associated noise and vibration, thereby limiting direct mortality and injury. Pelagic migratory fish species are typically found close to shore where currents are reduced, but movements may occur near the Project area for a small percentage of the time, generally in the upper 10 – 20 m of the water column (Appendix 4: Envirosphere 2009a) further limiting potential of injury or mortality. There are certain species however, which tend to hide rather than flee from threats and may be more likely to suffer injury or mortality as a result. Due to the limited species diversity and low population densities of marine benthic communities in the deployment area, it is unlikely that large numbers of fish species which rely on such communities for food may be present. Additionally, there is no information to suggest that the area of the Passage in the vicinity of the proposed Project represents key spawning habitat. Impacts (*i.e.,* direct mortality and injury of marine fish) from the installation and decommissioning of turbine devices and cables are likely to be minimal, with recovery to baseline levels occurring over the short-term. Once turbine devices and cabling have been secured to or removed from the seabed, there will be minimal impacts of this nature thereafter.

As noted, turbine and cable installations may result in the permanent alteration of a small area of fish habitat in the vicinity of the Project footprint. At the very least, project components will cover fish habitat and this could potentially have indirect adverse effects on marine fish through a reduction in the quantity or availability of primary food sources. This loss will be minor as the Project footprint will largely occur on scoured bedrock with very limited habitat and the turbine devices and the cables themselves have small individual footprints. It is anticipated that once turbine devices and cabling have been secured to or removed from the seabed, species will re-colonize disturbed areas; however, how long that would take is not known. The high currents would make relatively inhospitable conditions for recolonization of organisms on rock surfaces on the seabed, which is the reason that existing benthic communities in the area display limited species diversity and low population densities (Appendix 4: Envirosphere 2009a).

Project related drill cutting deposition has the potential to cover habitat within the potential zone of influence of sediment plumes, should drilling for turbine foundations is selected as the preferred method for MCT installation. Habitat covering is considered unlikely since the drill cuttings are extremely fine (< 3 mm) and will disperse in the water column (Verdi pers. comm. 2009). Any habitat covering that may occur will be minor as the Project footprint will largely occur on scoured bedrock with very limited habitat potential. In the event that drilling is required, typical procedures will be followed and a reverse uplift rock drill will be utilized in order to minimize the amount of cuttings deposited on the seabed. The geographic extent of such impacts (if drilling is required), is anticipated to be minimal in relation to the area of available habitat in the Minas Passage or the Minas Basin as a whole. It is anticipated that once the construction phase of the Project is complete, species will re-colonize disturbed areas, however, how long that would take is not known (as above).

Installation of turbine devices and cables will have some direct impacts on the substrate in the Minas Passage site but limited because no trenching will be done, and may initially remove some localized habitat that is potentially used by lobster. Lobster is the only commercial fishery located in the immediate area of the Project, while the most active lobster fishing nearest to the Demonstration Facility appears to occur closer to the shore (near Black Rock). The loss of lobster habitat due to the deployment of the turbines is likely to be geographically limited and of short-duration, as the lobsters that are displaced from the immediate Project footprint will return within a fairly short time period after the construction or decommissioning activity is completed and no major impact on catchability, as shown by studies related to seismic surveys (Payne *et al.* 2008, Martec Ltd. *et al.* 2004). Furthermore, the GBSs may act as alternative habitat for lobsters during Project operation as they could provide refuge from high currents in the area. The turbines will be between 350 m and 500 m apart, depending on the final micrositing for each turbine, so the three turbine devices are not likely act as a physical barrier to lobster passage through the area. Similarly, the cables on the sea bed are a maximum of 125 mm in height and therefore would not act as a physical barrier to lobster movement.

Fixed and moored structures typically become a focus for marine production (*e.g.,* reef effect) which further attracts marine life, including fish. Given the high current velocities in the Project area, the potential for this effect is reduced. In addition, where the turbine devices and their GBSs or foundations will be coated with an anti-fouling coating prior to deployment, this effect is expected to be minimized. As such, marine fish are not anticipated to be attracted to the turbines, although the structures may be used for temporary shelter.

Project related vessels will be used to some extent in all phases of the Project, increasing the level of marine vessels in the area. Due to the limited amount of time when velocities are low in the Passage, it is probable that construction activities will occur at any time of the day or night, in which case the effects of artificial lighting may become an environmental factor affecting fish behavior. Artificial lighting associated with nighttime operations may result in a localized behavioral modification for certain fish species, however the magnitude of the potential environmental effects is anticipated to be low, temporary and reversible, and limited in geographical extent.

To the extent that turbines and cables are not installed on scoured bedrock, Project construction and decommissioning activities will disrupt the seabed and will tend to remobilize sediments that are present on site, creating plumes that will travel away from the site for varying distances. Due to the depth of water, there will be limited opportunity for sediment disturbance from vessel prop wash. Installation of the MCT turbine may involve drilling for the installation of the foundation structure which may also result in increased turbidity levels. An increased suspended sediment concentration above background levels has the potential to interact with marine fish through habitat (water) quality degradation. High suspended sediment concentrations may damage gills, decrease feeding success, reduce rates of growth or embryo development, decrease resistance to disease and reduce the ability of marine fish to see and avoid predators, while also reducing the amount of light reaching any submerged vegetation thereby decreasing photosynthesis (Park 2007). High levels of suspended sediment may be a problem for filter-feeding species; especially those living in relatively clear water, however, these effects will vary depending upon the susceptibility of the species and the nature of the substrate at the site. Sublethal effects on a variety of fish species have been recorded by Appleby and Scarratt (1989), when species were continually exposed for a period of several days in waters with suspended sediment concentrations of approximately 650 mg/L or greater.

Activities associated with construction and decommissioning of the proposed Demonstration Facility are expected to be of short duration (*i.e.,* days) and intermittent as turbines and cables are installed over a two to three year period. It is expected that sediment plumes created from activities will quickly dissipate from the immediate area (within part of a tidal cycle) given the high current velocities, and are likely to be limited in magnitude (the Project footprint will largely occur on scoured bedrock), particularly if drilling is not required. As such, although elevated suspended sediment concentrations may cause temporary changes to marine water quality and thus marine fish habitat quality and use, particularly in the event that drilling is selected for MCT installation, it is unlikely that levels would increase to such an extent that fish would even be aware of the changes. Fish respond to much greater increases in suspended sediment in shallow estuaries and nearshore waters, but the change caused here will be negligible. There will not be any long-term effects and it is highly unlikely that there will be any direct mortality of marine fish from suspended sediment.

There are two main sources of noise and vibration within the context of the proposed Demonstration Project. The first is through installation and decommissioning which may include noise from turbine device and cable installation and the presence of boats and other equipment (*e.g.,* vessel engine noise, vessel ancillary equipment). The second concerns the potential noise emissions from the operation of the turbine devices themselves (CREST Energy Limited 2006). Marine fish utilize sound for communication, as well as for predator and prey detection, taking advantage of the rapid propagation of sound through water to perceive and discriminate sounds in the marine environment (Smith *et al*. 2004). Loud noises may result in behavioural responses, including avoidance of the source of noise which could result in avoidance of primary feeding or spawning grounds (Popper 2003).

Noise and vibrations during installation, operation and decommissioning activities may have important deterrent effects on fish, particularly with regard to migratory stocks, that are currently not understood. Due to the large number of various species which undergo migrations, collectively there will be limited time during the year when there are no fish moving through the Project area (Jacques Whitford *et al.* 2008). Forecasting these events and investigating mitigating actions requires further research. Available information suggests that Minas Channel, including the area of the proposed Demonstration Facility, is a migration route used by fish, including shellfish, in their seasonal movement in and out of Minas Basin to feed or reproduce. There is a known commercial fishery for lobster and the most active lobster fishing area nearest to the Demonstration Facility is closer to the shore (near Black Rock).

Very few studies have been conducted to determine the effects of high levels of ambient sound on fish; however, behavioural responses of fish to high levels of ambient sound may include temporary avoidance of the area, including avoidance of primary feeding or spawning areas for the duration of the disturbance (Smith *et al*. 2004; Popper 2003). Such behavioural responses could permanently affect behavioural patterns, reproductive success and survival rates. Other potential effects of high levels of ambient sound on marine fish include hearing damage which may increase risk of predation, alter reproduction or feeding behaviours, or initiate fish freezing (staying in place) which may further increase the risk of hearing damage (Popper 2003).

Most species of fish have the ability to detect low frequency sounds over great distances (Chapman 1973). Physiological effects of sound on fish have been summarized as follows:

- 192 dB (1 µPa) – transient stunning;
- 200 dB (1 µPa) – internal injuries;
- 220 dB (1 µPa) – egg/ larval damage; and
- 230 – 240 dB (1 µPa) – fish mortality (Turnpenny and Nedwell 1994).

Turbine generated noise is anticipated to be a continuous source that has the potential to interact with marine fish. Of the proposed device owners, OpenHydro is the only Project-specific device for which noise information is available, as the device holder undertook testing at the European Marine Energy Centre (EMEC) in the Orkney Islands, Scotland. Measurements were taken at ranges from 50 m to 790 m and were found to exhibit broadband (1 Hz to 120 kHz) sound pressure levels from 140 to 110 dB (1µPa), respectively. Based on these readings, the source level noise at 1 m is expected to be 162 dB (1µPa).

This is considerably below levels of noise that may cause mortality (230+ dB), physical injury or hearing impairment (220 - 230 dB) to marine fish of the area (Turnpenny and Nedwell 1994). At distances beyond 200 m, the turbine noise was difficult to identify above the ambient tidal water flow noise. As such, the extent of behavioural interaction with marine species is considered (by OpenHydro) to be limited to this range. The EMEC study concluded that unless marine organisms were in the immediate vicinity of the unit, behavioural interaction is unlikely.

Marine Current Turbines Ltd. (MCT) has operated a tidal current turbine, SeaFlow, off the coast of north Devon, at Lynmouth UK for the past three years. MCT has published information on the noise levels emitted during operation and a discussion of predicted impacts on a number of fish and mammal species (Parvin *et al.* 2005). The turbine at Lynmouth is different from the turbine proposed for the Demonstration Facility as it is equipped with a gearbox which generates additional noise. However, given the virtual lack of published data related to marine turbine operations, the following is provided for comparison.

Experimental results from the MCT study were used to draw conclusions for the environmental assessment of a potential marine current generation project in the Kaipara Harbour in northern New Zealand in 2006 (CREST Energy Limited 2006). The study indicated that marine species experience different source levels and transmission loss characteristics. In general, the attenuation of the sound for fish species is much more rapid than for marine mammals. The study indicated that the operational turbine noise was unlikely to have an impact on common fish species. For fish species with insensitive hearing, the turbine noise was not considered to be audible above background levels, potentially serving to warn off these fish species from the immediate area of the turbine, but unlikely to cause an avoidance response at any great range. For those fish species, the source level noise was not considered likely to cause a mild aversion response over a range of more than a few metres (CREST Energy Limited 2006).

Primary (immediate/ fatal effects) and secondary effects (injury to marine organisms) of underwater sound exposure are related to the overall Sound Pressure Level, impulse and acoustic peak pressures. It is expected the source level noise during operation of a 1 MW turbine will be below the levels at which both primary (above 230 dB) and secondary (220 – 230 dB) effects of the underwater sound are likely to occur (Parvin *et al.* 2005; Turnpenny and Nedwell 1994). As such, the noise generated during 1 MW tidal current turbine operations is therefore unlikely to cause mortality or injury to marine fish.

Based on the results of the MCT study, conclusions drawn in the CREST report and the noise monitoring results provided by OpenHydro, it is anticipated that marine fish present or migrating through the Project area may experience extremely limited behavioural changes (*i.e.,* avoidance and aversion over a few meters). Most pelagic fish species typically occur close to shore where currents are reduced, but movements may occur near the Project area for a small percentage of the time, generally in the upper 10 – 20 m of the water column (Parker *et al.* 2007 in Appendix 9 CEF, 2009) further limiting potential effects of noise and vibration to a small number of individuals. The extent of these effects is not known given the lack of specific information related to noise generated by the proposed devices, exact migration patterns and the background noise in the Project area.

Detection of such low frequency sound levels by crustacea, such as lobsters and crabs, is not well understood. American lobsters have no specific hearing organs and hearing has not been demonstrated (Cohen and Dijkgraaf 1961). However, this species is known to detect pressure waves. There is no documented evidence to indicate that chronic low frequency sound induces attraction or avoidance behavior in crustacea such as crabs or lobsters (Offutt 1970). Apart from direct displacement of a limited number of individual lobsters in the immediate Project footprint, there may be indirect effects on migrating lobsters during construction as a result of noise, vibrations, or sediments. Research is needed to assess the effects of these changes on lobster populations.

In general, the source level of ship noise increases with ship 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). As such, the noise generated by vessel traffic will vary depending on the activity and the vessels used. Marine construction (and decommissioning) activities will require large vessels and barges for turbine deployment and cable installation. Activities are expected to be of short duration (*i.e.,* days) and intermittent, given the proposed schedule. Vessel traffic during operations and monitoring is also expected to be of short duration and intermittent, and will use smaller vessels.

It has been reported by Richardson *et al.* (1995) that typical vessel traffic (*e.g.,* barges, tugs and bulk carriers) generally produce sound levels between 168 and 193 dB (1 μPa) at 1 m distance. Large vessels required during installation and decommissioning will be limited in number and duration of use. Support vessels used during construction and decommissioning and vessel requirements during operation will generally be small in size and limited in numbers. In addition, Minas Passage has traditionally been used by marine vessels, such that noise levels produced by the Project will not be abnormal when compared to background noise levels in the Passage. Based on the anticipated noise levels resulting from Project related vessel traffic, no adverse effects on adult, juvenile, eggs or larvae of commercial or non-commercial species are expected, as noise levels will not exceed the thresholds for damage to marine fish. However, given the virtual lack of published data related to marine turbine operations, noise monitoring during operation of the turbines is recommended.

Operation

Fish mortality caused by collisions with the turbines themselves was noted as a concern in the Background Report and the SEA. Marine fish mortality could occur if fish strike rotating blades, housing or fixed parts of the turbine structures or if there is a sudden pressure drop as the fish proceeds through the device. Although much experience on assessing mortality rates has been gained through investigation of hydroelectric installations, and locally at the Annapolis Tidal Generating Station (BEAK Consultants 1991; Dadswell and Rulifson 1994; Solomon 1988; Stokesbury *et al.* 2001), there is no information currently available in relation to the new TISEC technologies. It is not clear the importance or to what extent TISEC devices will emit vibrations or noise that will affect the behavior of fish in the vicinity. If fish do not avoid the turbine devices, then their vulnerability to damage on passage through a TISEC device will vary according to the design characteristics and location of the device, as well as specific fish characteristics. Consequently, this is very much a technology, site, and species-specific interaction requiring further research for each different TISEC design.

Turbines will be mounted on steel "gravity based structures" (GBS). In the case of the MCT device, specific details regarding installation are not yet finalized; the turbine will either be mounted on a steel GBS or a pin pile foundation set into sockets drilled into the seabed. Turbine devices will sit on the seabed, such that that the generator and moving parts are 5 - 10 m above the bottom and the top of the turbine blades would be approximately 10 m below sea level at low tide. Therefore, species that move in the mid-water zone are more likely to interact with the device than those which move close to the bottom or the few which move close to the surface. It is also expected that tightly schooling fish may be more vulnerable than solitary ones.

Various fish species migrate into Minas Basin through Minas Passage through the year. These include pelagic species such as Inner Bay of Fundy Atlantic Salmon, striped bass, herring and American shad, as well as species that occur typically near bottom (*e.g.,* sculpin, sturgeon), and American lobster. Pelagic migratory fish are likely found close to shore (*i.e*., 100 - 200 m) where currents are reduced, although the actual patterns are not known. In general, high currents and turbulence in the water column are not preferred by most fish. For a smaller percentage of the time, movements may involve passage further from shore, where the fish could be transported past turbines by tidal currents. Thus there is a small likelihood that a small proportion of most pelagic species will encounter turbines at some point while passing through Minas Passage. The fish would also probably be more likely to be in the upper 10 - 20 m of the water column, where they could occasionally encounter turbines, but again the most likely depth distribution is not known. Bottom-associated species will move near bottom where bedrock outcrops may be used for refuge during high tidal currents, and would likely be below depths influenced by the turbines. Lobster move along the bottom through Minas Passage to spawn in Minas Basin in summer and they would likely favour movement during slack tidal periods and be near bottom and out of zones influenced by the turbines (Appendix 4: Envirosphere 2009a).

The Clean Current and OpenHydro devices have been designed to minimize the potential for injury to marine fish and marine mammals. Turbine blades are enclosed by a shroud or ducts designed to prevent fish and sea mammals from coming into contact with the blades. A large open centre is intended to provide safe passage for marine life that may unexpectedly encounter the turbine. The ducting also attenuates turbine noise which could potentially act as deterrent to marine fish in the immediate vicinity.

The size of the animal is clearly a factor in any risk of collision. The environmental assessment of the marine current generation project in the Kaipara Harbour in 2006 utilized a Rotech Tidal Turbine (RTT), which appears to be most similar to the Clean Current device, and determined that species with a cross-sectional area of 6.5 m or more (i.e., marine mammals) seeking to pass between the blades will impact a rotor blade (CREST Energy Limited 2006). Additionally, if the turbines are moving slowly enough (*i.e.,* 25 - 50 rpm) fish kills are minimized (Pelc and Fujita 2002). Turbine devices to be utilized in the Demonstration Project will spin slowly (*i.e.,* 10 – 30 rpm), thereby minimizing the likelihood of mortality of marine fish resulting from turbine operation. In contrast, ship propellers are commonly driven at more than 1,000 rpm and therefore at much higher tip velocities. Also, engine-driven ships and boats (and their propellers) move through the water with high velocity, sucking anything nearby towards the propeller, whereas the turbine itself is stationary, passive and does not create suction. Yet, ships and boats seemingly cause no major mortality of marine fish (CREST Energy Limited 2006). In summary, the risk of collision by fish is considered to be extremely low.

The alteration in water velocity and turbulence as a result of flow around and through TISEC structures has the potential to affect fish and benthic habitats by changing sediment deposition patterns, by reducing downstream flow of nutrients and food supply, and directly or indirectly affecting prey types and availability in the area of influence of the turbines (Wilson *et al.* 2007). There have been no comprehensive analyses of these potential effects conducted for any TISEC installations to date. The area of flow disturbance downstream of a turbine will vary by device, but as an example, MCT has suggested that 10 rotor diameters is the appropriate downstream distance between turbines to optimize their performance.

An initial evaluation by the US Department of Energy notes that velocity and turbulence effects will vary greatly, depending on the distance from the structure. For a small number of units, such effects are expected to be localized (USDOE 2008). Based on the limited number of TISEC devices to be operated as part of the Demonstration Project, and based on the fact that the turbines will be placed on highly scoured bedrock areas, only minimal impacts on fish and fish habitat from flow and turbulence changes are anticipated.

Mitigation of direct turbine mortality may be possible if operational monitoring indicates that fish strikes are occurring. Research at the Annapolis Tidal Generating Station has shown that fish can be driven away from the turbine entrance by acoustic devices set nearby (McKinley and Kowlyk 1989). Such strategies may be considered if it appears that fish do not avoid the structures. The Demonstration Facility offers the opportunity for such research to be undertaken before commitments to large scale arrays are made.

During the operational phase of the Project, electromagnetic fields (EMFs) due to the subsea cable may be produced. EMFs are generated through the acceleration of charged particles. When the velocity of a charged particle fluctuates, an EMF is produced which could potentially interact with marine fish that are sensitive to such fields. As stated in the Background Report, the scale of specific impacts on the marine environment created by the presence of EMFs is not known; however, research is presently underway to better understand the magnitude of EMF impacts (Jacques Whitford *et al.* 2008). Offshore marine wind farms operating in Europe provide evidence that the behavior of many species may be modified by the presence of underwater electrical cables generating EMF (Dong Energy *et al*. 2006). Previous studies in offshore oil and gas industry did not identify physical barriers (pipelines) to the movement of lobsters, nor did noise and EMF generally affect this activity (Martec Ltd *et al.* 2004). There is a clear need for experimental investigation of the effects of EMF on the health and behavior of such species, especially those that are components of important fisheries, or upon which other fish species depend.

Fish, particularly elasmobranches (skates and rays), are the most sensitive to EMF impacts due to their dependence on the geomagnetic fields for navigational purposes and prey detection. These organisms are referred to as electrosensitive species and the impacts range from the cellular to the behavioural level. The concern for EMFs extends beyond the creation of the fields themselves but also considers the colonization of species on artificial substrate and the impact that may have on electrosensitive predacious species. There is very little information about the effects of EMF on the behavior of marine organisms associated with the bottom substrate, such as dermesal fish and mobile invertebrates. EEM programs to be developed in support of the Project-specific EMP will be based on adaptive management principles and include research on the effects of EMF to confirm the uncertainty and predictions made with respect to the Project as well as to confirm the appropriateness and effectiveness of the mitigation undertaken.

Many species of elasmobranch are able to detect induced electric fields from typical underwater cables (1-1000μV/m) (Centre for Marine and Coastal Science [CMACS] 2003; Gill et al. 2005). According to modeling, the electric field from a typical 132kV cable is estimated at 91.25μV/m (Gill et al. 2005), which is just below the level believed to induce avoidance behaviour (100μV/m and greater) in sharks (Gill and Taylor 2001). The direct magnetic field estimated from a typical 132kV cable would only be 1.6 μT at the cable surface, well below the range believed to be detectable by elasmobranches (25- 100μT) (Gill et al. 2005). The subsea cable associated with the Project is a 34.5kV cable, a much smaller output than those modelled. It is therefore inferred that even the most sensitive fish species are not anticipated to demonstrate avoidance behaviour and will not detect the magnetic field generated by the cable.

Although some (induced electric) field avoidance responses have been documented in experimental studies (e.g. Gill and Taylor 2001), empirical evidence is currently lacking to establish if existing marine cables have had any significant impacts on elasmobranch behaviour or migration patterns (CMACS 2003; Gill et al. 2005; FMM 2007). Although cables will not buried for the Demonstration Project, the cables will be armoured with two layers of galvanized steel wire.

During operation of the proposed Demonstration Facility, there is the potential for re-suspension of sediments (temporary habitat quality degradation), as well as the redistribution of sediments resulting from reductions in the kinetic energy of the water that has passed through turbine devices. It is not expected that the Demonstration Project in Minas Passage will have sufficiently large effects on current velocity through the Passage to be detectable in any of the critical processes in the Minas Basin.

The Project footprint will largely occur on scoured bedrock such that it is unlikely that suspended sediment levels would increase to such an extent during Project operations that fish would even be aware of the changes. Fish respond to much greater increases in suspended sediment in shallow estuaries and nearshore waters, but the change caused here will be negligible (Stewart pers. comm. 2009). There will not be any long-term effects on habitat quality.

Turbine operation could potentially result in changes to the patterns of sediment distribution, which in turn may have an environmental effect on marine fish and invertebrates; however, this issue is not well understood. Reductions in current velocity affect the transportation and deposition of sediments while sediment properties affect the benthic organisms that inhabit them, and consequently the fish and other species that feed upon the benthics. The distribution and abundance of marine fish species are largely a function of sediment properties, which could potentially be changed as a consequence of tidal power development (Jacques Whitford *et al.* 2008). A decrease in turbulence downstream of a turbine device as a result of energy conversion may affect the ability of marine fish to obtain their food. As per the SEA and the Background Report, it is acknowledged that a demonstration scale project will not likely have any measurable effects on physical processes beyond the immediate area (OEER 2008), such that effects on marine fish resulting from changes in sediment distribution are not likely to be significant.

Sampling of sediment concentrations and grain size in the water column will be undertaken prior to deployment of the proposed Project, and will continue during operations. Ultimately, developing an adequate model of sediments dispersion, including changes that may occur through TISEC development, will be required to predict the effects of commercialization.

In summary, it is anticipated that marine fish present or migrating through the Project area may experience very limited behavioural changes such as avoidance and aversion, as well as limited mortality and habitat disruption. The extent of these effects is not known given the lack of specific information related to noise generated by the proposed devices, and the background noise in the Project area. Noise monitoring during operation of the turbines is recommended (see below).

6.2.5 Follow-up and Monitoring

The response of marine fish to TISEC devices is currently unknown, and this is a critical gap in knowledge. It is essential to know how marine fish and mobile invertebrates behave in the vicinity of each turbine device in order to forecast the effects of commercial development. This is a key requirement for research and monitoring at The Demonstration Facility. Experiments at the Race Rocks in British Columbia, the East River in New York, and the EMEC site in Scotland have so far provided no indication that marine fish come close to the turbines during operation, however, only the Verdant experiment in the East River was designed to monitor the behavioral responses of fish (Jacques Whitford *et al.* 2008). Because of the varied TISEC designs, such research will be needed for each device.

FORCE and the device owners will implement a detailed monitoring program for the Demonstration Facility. The details of the program will be developed in consultation with federal and provincial regulatory agencies and incorporated into the Environmental Management Plan for the Project.

Noise monitoring is anticipated to include:

- Collection of ambient noise levels in the area of the turbine devices;
- Collection of noise data for each of the turbines during regular operation; and
- Collection of noise data at a control point established so as to capture cumulative noise emissions from the three devices.

The above information will be used to confirm the predictions made in this assessment related to the environmental effects of turbine noise emissions on marine fish. It will also be used to model the potential cumulative noise emissions for potential future commercial tidal energy developments.

In addition to monitoring for noise, additional information related to the presence of marine fish in the Project area will be gathered via observations made during all marine construction, operation, and decommissioning activities in combination with scientific research. Multi-year studies currently underway at Acadia University will attempt to assess the American lobster and striped bass populations of the Minas Channel and Basin and their movements in relation to the general location of the Demonstration site. The work addresses lobster and striped bass population characteristics, migration pathways and possible impacts of the Demonstration site for both the species and fishermen. These efforts will ensure that the frequency and species distribution in the Project area are better known prior to commercialization. FORCE will also work with local fishers to gather additional observational data. As above, this monitoring information will be used to confirm the predictions made in this assessment and to further inform future commercial developers through modelling.

Changes in sediment distribution potentially resulting from the installation and operation of turbine devices may result in changes to invertebrate populations, which in turn may have effects on marine fish. An objective of the Demonstration Facility is to gather information that will serve to further evaluate the potential effect of larger scale development. The Project monitoring program will include monitoring of currents and suspended sediments around turbines (including a control point) and other related aspects, including video surveys to gauge changes in sediment deposition, where possible. On a larger scale, hydrodynamic modeling within the Bay of Fundy, conducted by regulatory agencies and academia, is expected to address far field effects resulting from changes to currents, tides and sediment dynamics.

6.2.6 Summary of Residual Environmental Effects Assessment

The fundamental knowledge required to assess the environmental effects of TISEC on marine fish does not currently exist; consequently, building the research knowledge base among the scientific community of the Bay of Fundy represents a valuable asset that will amplify the potential for this region to become a global centre of excellence in marine energy developments (Jacques Whitford *et al.* 2008). It is acknowledged that there is a degree of environmental risk involved in Project development that cannot be completely eliminated due to this lack of knowledge. Monitoring and follow-up, described previously, will be an integral part of confirming the predictions of this assessment, informing future commercial developers and will provide opportunities for further research on the Minas Passage, the Project and potential interactions.

By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine fish within the Project area or vicinity *(i.e.,* Minas Passage and Minas Basin). In general, this is due to the relatively small scale of the project, combined with the limited duration and intermittent nature of the Project activities.

Accidents, malfunctions and unplanned events are assessed in Section 7.0 and cumulative environmental effects are assessed in Section 8.0.

6.3 Marine Mammals

Marine Mammals is retained as a VEC in consideration of the potential environmental effects of Project components and Project-related activities on existing populations of these species in Minas Passage. This VEC was selected to meet regulatory requirements and due to the important role that marine mammals play in the marine ecosystem. These species are also of public concern and of socio-economic importance for the tourism industry in the Bay of Fundy (*i.e.,* whale watching).

Marine Mammals refers to seals, dolphins, whales and porpoises that may be present for at least part of their life cycle (*e.g.,* breeding, feeding, and migration) in the Minas Passage. Marine mammals that are considered at risk are addressed in Section 6.5 of this assessment.

Marine Mammals are closely linked to the presence of Marine Fish, which are an important source of food for these populations, and thus the assessment of Project environmental effects on Marine Fish and Water Quality should be consulted (Section 6.2). Similarly, Marine Benthos are an important food source for marine fish; therefore the Marine Benthos section (Section 6.1) should also be consulted.

6.3.1 Boundaries

The spatial boundary of interaction is primarily the zone of influence of the turbines and the operating area of installation vessels. In the event of an accidental spill, the spatial boundary will encompass the anticipated zone of influence of the spill. Spatial ecological boundaries for cetaceans include seasonal migration corridors and feeding areas. Most species of marine mammals within the Project area are migratory, entering the Bay seasonally for breeding and feeding, while some species are present year round in offshore waters.

The temporal boundary for the assessment of environmental effects to marine mammals includes the construction, operation and decommissioning phases of the Project. The temporal ecological boundaries will vary according to species and will consider seasonal patterns and movements of different species of marine mammals, including breeding seasons and particular times of year when these species are most likely to be present in the Minas Basin or most-likely to have migrated out of the basin.

Marine mammal species are protected under the federal *Fisheries Act* and administratively managed by DFO. Field studies, marking, and collecting samples from marine mammals, both alive and dead, are permitted only with authorization by DFO. *SARA* provides legal protection for some rare marine mammal species that have been proclaimed as endangered, rare or vulnerable under the *Act*. The Nova Scotia *Endangered Species Act* in addition to *SARA* offers legal protection to some rare species that have been proclaimed as endangered, rare, special concern or vulnerable under the *Acts* (see Section 6.5). In Nova Scotia waters, only seals are commercially exploited or used for subsistence.

A key technical limitation of the assessment is the lack of detailed information available on the presence and movements of marine mammals in the Minas Basin. General information on marine mammals in the Minas Basin and other published information on marine mammals in Nova Scotia waters have been used to determine which species could potentially be present in the Minas Basin for at least part of their life-cycle. This general information has been supplemented with data specific to the Minas Basin where available, including project-specific observational data and information from contacts with the Canadian Wildlife Service and DFO.

Another technical boundary is the limited knowledge of the effects of tidal energy technology on marine mammals. Limited studies have been conducted given that the technology is considered new and there is limited published information.

6.3.2 Residual Environmental Effects Evaluation Criteria

A **significant** effect to marine mammals is defined as an unnatural decline, over one or more generations, in the abundance and/or change in the distribution population of a species or portion thereof, permanent avoidance of the area by marine mammals, or a serious injury to or the loss of one or more individuals from an endangered or threatened species. Natural recruitment may not re-establish the population, or any populations or species dependent upon it, to its original level within one or more generations.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect to marine mammals is defined as one that results in a measurable population increase and/ or enhances the quality of critical habitat.

6.3.3 Potential Issues, Interactions and Concerns

Potential interactions between the Project and marine mammals relate primarily to:

- Mortality due to vessel strikes;
- Disturbance of marine mammals caused by the presence of the turbines and installation and monitoring equipment and vessels, particularly with regard to collisions;

- Disturbance of marine mammals caused by drilling for MCT pile foundations;
- Noise and vibration generated by the turbines during operation leading to masking of cetacean vocalization; temporary threshold shift or hearing impairment; behavioral effects (*e.g.*, avoidance, changes in migration, or reproductive and feeding behaviors); or physical injury;
- Mortality due to turbine strikes;
- Indirect effects through changes in prey distribution and abundance; and
- Accidental spills leading to potential contamination of species at risk (addressed in Section 7.0, Accidents, Malfunctions, and Unplanned Events).

Cetaceans (*i.e.,* whales, dolphins and porpoises) have very low reproductive potentials, rendering them particularly vulnerable to anthropogenic impacts (NSM 1996). Small cetaceans have shorter life spans (ranging from 15 - 30 years) compared to large species, which may live to be over a century in age (Hoyt 1984). Marine mammals are sensitive to noise, some species more than others. There is limited information related to the behavioural responses of marine mammals to TISEC devices. Furthermore, there is a relative low confidence level with respect to the occurrence information for marine mammals in the Project area.

The Project will involve the use of large slow moving barges and vessels for turbine deployment and cable installation. Vessel traffic will be limited during the operations phase to small and medium sized vessels (*e.g.,* fishing vessels) used for various monitoring programs. Vessel traffic during decommissioning is expected to be similar to the construction phase. The increased vessel traffic in the Minas Passage (above existing commercial fishing and industrial vessel traffic) increases the potential for vessel collisions with mammals. Also, the increased vessel traffic increases the noise level in the Passage.

Installation of the MCT turbine may involve drilling for the installation of the foundation structure. This activity will result in increased noise and increased turbidity which has the potential to interact with marine mammals.

In addition to the potential interactions associated with vessel traffic, the presence of the turbines and the noise emissions from their operation has the potential to interact with marine mammals that may be present or migrate through the Project area, causing direct or indirect effects.

6.3.4 Analysis, Mitigation and Residual Environmental Effects Prediction

The vessel traffic associated with the all phases of the Project has the potential to either attract marine mammals or frighten them away, depending on the type of activity. Some mammals may be indifferent. Evaluating other offshore activities, the Sable Offshore Energy Project (SOEP) conducted year-round daily observations of marine mammals from its platforms since 1998 (Hurley 2000). Cetaceans were observed close to platforms for the SOEP Tier I drilling program. Baleen whales and toothed whales frequent SOEP platforms, sometimes feeding with young within the immediate vicinity of the platform. Given that whales nurse their young for extended periods, the presence of young cetaceans within groups that approach the site may imply some conditioning of the adults to offshore activity. It is not known if similar behaviour will be observed for the proposed Project.

Some dolphin species are well known for bow riding, and baleen whales have been known to approach fishing vessels at the sound of trawl doors being raised (Brodie pers. comm. 2001, cited in EnCana Corporation 2002). The concern related to attraction of mammals to vessel traffic is the increased likelihood of collision.

Vessel collisions with marine mammals are more likely to occur when vessel speeds are high and with slow-moving marine mammals such as whales. Such events are rare. Collisions with dolphins and harbour porpoises are reduced given that these mammals are fast swimmers and are able to swim away or dive to avoid vessels. The likelihood of collision can be decreased significantly by vessels maintaining constant speed and course while in transit (Thomson *et al*. 2000), as would be the case in this Project.

Fixed and moored structures typically become a focus for marine production (*e.g.,* reef effect) which further attracts marine life, including mammals. Where the turbine devices and their GBSs or foundations will be coated with an anti-fouling coating prior to deployment, this effect is unlikely. The high current velocities also serve to reduce this effect. Given this, marine mammals are not expected to be attracted to the turbines.

Marine mammals create sounds to communicate the presence of danger, food, other animals, positioning, identity, territorial and reproductive status. Some species use sonar to track prey. Certain species are more sensitive than others to different noise levels and have different adaptations to cope with extensive ambient sound. Cetaceans are known to use echolocation as a means by which to detect and characterize underwater objects. It is these sounds and the potential adverse effect of the noise associated with increased vessel traffic on these activities that raise concern.

In general, the source level of ship noise increases with ship 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). As such, the noise generated by vessel traffic will vary depending on the activity and the vessels used. Marine construction (and decommissioning) activities will require large slow moving vessels and barges for turbine deployment and cable installation. Activities are expected to be of short duration (*i.e.,* days) and intermittent given the proposed Project schedule. Vessel traffic during operations and monitoring is also expected to be of short duration and intermittent, and will use smaller vessels.

The spatial distribution of marine mammals in the Minas Basin is not well known. Based on the likely distribution of marine mammals in the deployment area, underwater noise produced during construction activities is most likely to affect seals and harbour porpoises, as larger marine mammals such as whales are not known to be present in the Minas Passage on a regular basis.

The noise associated with vessel traffic, particularly for construction and decommissioning, may disturb marine mammals causing them to avoid the work area. At close proximity, these sounds have the potential to impair marine mammal feeding efficiency, predator detection, and/or migratory success (Richardson *et al.* 1995). Marine vessels produce low-frequency sounds with most acoustic energy below 1 kHz. As seals and harbour porpoises are most sensitive to mid-frequency sounds (> 1 kHz), much of the acoustic energy produced by vessel traffic will not be audible to these marine mammals. These behavioural effects described above will subside once the activities are complete.

Turbine generated noise (which will be continuous) is another source that may interact with marine mammals. Of the proposed device owners, OpenHydro is the only device for which noise information is available, as described in Section 6.2. Measured noise levels were considerably below levels that may cause mortality, physical injury or hearing impairment to marine mammals of the area (Turnpenny and Nedwell 1994). At distances beyond 200 m, the turbine noise was difficult to identify above the ambient tidal current flow noise. Given this, the extent of behavioural interaction with marine species is considered (by OpenHydro) to be limited to this range. The study concluded that unless marine organisms were in the immediate vicinity of the unit, behavioural interaction is unlikely.

In addition to the above, Marine Current Turbines Ltd. (MCT) has published information on operational noise levels and a discussion of predicted impacts on a number of fish and mammal species (Parvin *et al*. 2005). Their turbine at Lynmouth, UK is different from the turbines proposed for the Demonstration Facility as it is equipped with a gearbox which generates additional noise. However, given the virtual lack of published data related to marine turbine operations, the following is provided for comparison.

The MCT study assessed potential impacts on a number of fish species and on harbour porpoises and the common seal. The study noted that marine mammals have more sensitive hearing than fish and that in particular their audible range extends to much higher frequencies. Marine mammal species hear sound well at high frequencies. Optimum hearing for the harbour porpoise occurs over the frequency range from 4 kHz to 50 kHz. The species-dependent analyses indicated the common seal experiences background noise (at Lynmouth) at 44 dB, and the harbour porpoise at a level of 58 dB; that is, the underwater noise environment in tidal flow regions is already at a relatively high level for marine mammals. Given the tidal flow characteristics of the Bay of Fundy and the Minas Passage, it is anticipated that the mammals in the Project area would be subject to a significant background sound profile; however there is no specific information available regarding the range.

Results from the MCT study indicate that different marine species experience different source levels and transmission loss characteristics. In general, the attenuation of the sound for fish species is much more rapid than for marine mammals. It was found that a significant avoidance reaction in a given mammal species will occur when the level exceeds 90 dB from the turbine for that species. For the Harbour Porpoise, sound is likely to approach and exceed this level at a distance of approximately 3 m from the turbine. At a level of 75 dB from the turbine (for a given species) a mild avoidance reaction is likely and a proportion of individuals of that species are likely to avoid or move away from that area. Below 75 dB emitted from the turbine it was found that it is unlikely that sound will cause avoidance in a species, unless the sound is aversive by its nature.

Primary (immediate/fatal effects) and secondary effects (injury to marine organisms) of underwater sound exposure are related to the overall sound pressure level, impulse and acoustic peak pressures. It is expected the source level noise during operation of a 1 MW turbine will be below the levels at which both primary (above 230 dB) and secondary (220 - 230dB) effects of the underwater sound are likely to occur (Parvin *et al.* 2005 and Turnpenny and Nedwell 1994). As such, the noise generated during 1 MW tidal current turbine operations is therefore unlikely to cause fatality or injury to marine mammal species.

Based on the results of the MCT study and the noise monitoring results provided by OpenHydro, it is anticipated that marine mammals present or migrating through the project area may experience some behavioural changes such as avoidance and aversion. The extent of these effects is not known given the lack of specific information related to noise generated by the proposed devices, and the background noise in the Project area.

As indicated in the Background Report (Jacques Whitford *et al.* 2008) there is little evidence that marine mammals come into contact with large stationary objects in the marine environment. Marine mammals are more likely to contact fishing gear that may be too small to be detected or with moving objects such as vessels. There is potential however for underwater noise or vibrations the turbine devices to confuse signals and diminish the mammals' capacity to discriminate fixed structures, which might result in them striking a device.

Tidal currents flow through turbines in a helical path through the turbine such that any passive, neutrally buoyant object will follow a path aligned with the rotor blades rather than across them. This occurs because water slows down as it passed through the turbine due to the removal of energy. Furthermore, as water slows down it spreads to occupy a greater cross-sectional area. The rotating turbine blades deflect the current tangentially into helical pathways, at velocities proportional to the distance from the rotational centre of the turbine (CREST Energy Limited 2006). A marine animal approaching a turbine by swimming downstream will tend to follow the helical path (*i.e.,* it will not swim directly through the plane of rotation, but rather will be swept tangentially with the helical movement of the currents). Subsequently, after passing the turbine, the animal would be swept along with the current as the helical flows gradually regain the natural flow (CREST Energy Limited 2006).

When considered in the context of more common underwater hazards, the risk of damage to marine wildlife from the relatively slow moving rotors of a tidal turbine (less than 50 rpm) are small compared with those from ship propellers (in excess of 1,000 rpm) on vessels moving at much faster speeds than marine animals.

In addition to the above discussion, sound and visibility provide important cues to marine creatures in avoiding hazards. Marine wildlife has evolved to avoid collisions with natural features such as rocks, obstructions or moving vessels. Furthermore, the species that favour swimming in strong currents tend to be fast and agile and are expected to be able to avoid fixed objects.

Dolphins and cetaceans generally, have large eyes, large cornea and large pupils. When approaching the surface, their pupillary opening is constricted rapidly to restrict access of excess light. Underwater, their eyes provide excellent definition, while they have the ability to amplify light sensitivity more than 10-fold when they dive to depths. These visual characteristics provide dolphins and cetaceans with equally sharp vision above and below water and will help to mitigate the risk of inadvertent collision with underwater turbine structures (CREST Energy Limited 2006).

Seabird and Marine Mammal observations were undertaken on four occasions in 2008 during the course of field survey work: incidental observations were made during surveys in February and March 2009, and dedicated observers made observations on the other two surveys (one biologist in July and a team of two biologists in October 2008). The July and October surveys used standardized seabird and marine mammal observation protocols. Seabird and Marine Mammal observations are reported in Appendix 7: Envirosphere 2009c Seabirds and Marine Mammals, however no marine mammals were observed during these surveys.

6.3.5 Follow-up and Monitoring

FORCE and the device owners will implement a monitoring program for the demonstration facility. The program will be developed in consultation with federal and provincial regulatory agencies and incorporated into the Environmental Management Plan for the Project.

Noise monitoring is anticipated to include:

- Collection of ambient noise levels in the area of the turbine devices;
- Collection of noise data for each of the turbines during regular operation; and
- Collection of noise data at a control point established so as to capture cumulative noise emissions from the three devices.

The above information will be used to confirm predictions regarding the environmental effects of turbine noise emissions on marine mammals made in this assessment. It will also be used to model the cumulative noise emissions for potential future commercial tidal energy developments.

In addition to monitoring for noise, additional information related to the presence of marine mammals in the Project area will be gathered via observations made during all marine construction, operation, and decommissioning activities. FORCE will also work with local fishers to gather additional observation data. As above, this information will be used to confirm the predictions made in this assessment and to further inform future commercial developers.

6.3.6 Summary of Residual Environmental Effects Assessment

By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine mammals within the Project area or vicinity (*i.e.,* Minas Passage).

Accidents, malfunctions and unplanned events are assessed in Section 7.0 and cumulative environmental effects are assessed in Section 8.0.

6.4 Marine Birds

Marine Birds are retained as a VEC in consideration of the potential environmental effects of Project components and Project-related activities on existing populations in the Minas Passage. This VEC was selected to meet various regulatory requirements and due to the important role that marine birds play in the marine ecosystem. Marine birds reflect the diversity of habitats and processes that are to be found in the ecosystem (Jacques Whitford *et al.* 2008).

Marine Birds includes all species of birds which are present for at least part of their life cycle (*e.g.,* breeding, feeding, and migration) in the Minas Basin. Environmental effects to bird species that depend primarily on terrestrial habitats have been assessed in Section 6.7, Terrestrial Wildlife and Wildlife Habitat. Birds that are considered at risk for the purpose of this assessment are those species that spend large parts of their life cycle in Minas Basin, and that have been identified by federal or provincial agencies as being endangered, threatened, rare, special concern or otherwise of conservation concern. Species at risk are important indicators of ecosystem health and regional biodiversity and are assessed in Section 6.8, Terrestrial Species at Risk.

Marine Birds are closely linked to Marine Fish and Marine Benthos, which are an important source of food for these populations, and thus the assessment of Project environmental effects on Marine Fish and Water Quality (Section 6.2), as well as Marine Benthos (Section 6.1) should be consulted.

6.4.1 Boundaries

Most bird species that frequent marine habitats around Nova Scotia, including the Bay of Fundy, are migratory. Temporal boundaries vary depending on the species, each having its own annual peak abundance along the coasts or in offshore waters. Two species potentially feeding, or resting and stopping over in the study area (*i.e.*, American peregrine falcon, common loon) are considered at risk and may be particularly sensitive to development activities (Section 6.8, Terrestrial Species at Risk). However, all species that spend a significant portion of their breeding or non-breeding seasons in the study area may also be affected. While construction activities will occur intermittently at different locations (*i.e.*, turbine berths and along the cable corridor), operations will be continuous in subsequent years; therefore interactions between the Project (specifically with the surface piercing MCT structure) and marine birds could occur at any time during the life of the Project.

The spatial boundary of interaction between Project activities and marine related birds is the Project footprint and zone of attractiveness, if any, of the turbine deployment area, cable corridor and associated activities. In the event of an accidental spill, the spatial boundary will encompass the anticipated zone of influence of the spill. Accidents, malfunctions and unplanned events are assessed separately in Section 7.0.

The *MBCA* administered by CWS, protects all migratory bird species in Canada, prohibiting the killing, injuring or harassing of migratory birds, or the destruction of their eggs or their young without a permit. The Nova Scotia *Wildlife Act* and Regulations protect all non-game bird species not considered pests, while non-migratory game birds are protected (outside of hunting seasons) as defined by NSDNR. Game birds are under the management NSDNR.

6.4.2 Residual Environmental Effects Evaluation Criteria

A **significant** effect to marine birds is defined as an unnatural decline or change in abundance and/or distribution, over one or more generations, of a population of a species or portion thereof, permanent avoidance of the area, serious injury to or the loss of one or more individuals from an endangered or threatened species, the loss of its critical habitat, or any substantial change in migration patterns. Natural recruitment may not re-establish the population, or any populations or species dependent upon it, to its original level within several generations.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect to marine birds is defined as a measurable population increase or enhancement in the quality of habitat for marine related bird species.

6.4.3 Potential Issues, Interactions and Concerns

A number of activities associated with the construction, operation and decommissioning of the marine components of the Demonstration Facility (*e.g.,* installation, operation and decommissioning of turbine devices and cables) could interact with marine birds. Potential effects on marine birds during all phases of the Project may be either direct or indirect. Such effects may include direct mortality, alteration, disruption, or destruction of key habitats and food sources. There is limited information related to the behavioural responses of marine birds to TISEC devices.

While construction activities will occur intermittently at different locations (*i.e.*, turbine berths and along the cable corridor), operations will be continuous in subsequent years; therefore, interactions (*e.g.,* bird strikes) between the surface piercing structure and marine birds could occur at any time during the life of the Project. Based on the present scenario for the MCT generator, there will be a visible portion of the turbine's support structure projecting above the sea surface. The area to be occupied by the surface piercing structure will be insignificant in relation to the area of available habitat in the Minas Passage or the Minas Basin as a whole and in addition, there is no information to suggest that the Passage is a significant concentration area for marine birds.

Project related vessel strikes can lead to the direct mortality or injury of marine birds, as well as increased levels of noise which may cause some marine birds to exhibit localized temporary avoidance behaviour in the area of the vessels. The proposed Project will involve the use of large slow moving barges and vessels during construction for the deployment of the turbine devices and installation of the cables. Vessel traffic during the operational phase of the Project will be limited to small and medium sized vessels (*e.g.,* fishing vessels) to be utilized for various monitoring programs, while traffic during the decommissioning phase of the Project is expected to be similar to the construction phase. Increased vessel traffic in the Minas Passage, in addition to existing commercial fishing and industrial vessel traffic, increases the potential for vessel collisions with marine birds. An increase in vessel traffic could also potentially increase the risk of accidental spills in the marine environment which could have environmental effects on populations of marine birds and their habitats. Accidental events are discussed in Section 7.0 of this document.

Installation the turbines and cables could potentially affect marine birds through permanent alteration of an area of marine habitat (*i.e.,* Project footprint). However, no marine bird habitat will be lost through this Project.

Installation of the MCT turbine may involve drilling for the installation of the piled foundation structure, resulting in increased noise and increased turbidity which has the potential to indirectly interact with marine birds. The distribution and abundance of marine bird prey species are a function of sediment properties, which could potentially be changed as a consequence of tidal power development (Jacques Whitford *et al.* 2008). No blasting will be required for construction, thereby reducing the amount of turbidity and noise during installation.

Increases in noise (magnitude, frequency, duration and character) above background levels from construction or decommissioning or increased vessel traffic may result in changes to behaviour and habitat use by marine birds. Noise associated with turbine and cable installation or decommissioning could cause some marine birds to temporarily avoid this particular area of the Minas Passage. Once construction and decommissioning are complete, the disruption to marine birds will subside. Minas Passage has traditionally been utilized by marine vessels, such that noise levels produced by the construction and decommissioning phases of the Project will not be abnormal when compared to background noise levels in the Passage.

In addition to the potential interactions associated with vessel traffic, the presence of the turbines themselves and the noise emissions for their operation has the potential to interact with marine birds that may be present or migrate through the Project area causing direct or indirect effects.

6.4.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Marine birds may potentially collide with surface piercing structures resulting in injury or direct mortality. Such events are expected to be rare. Most of the offshore area occupied by the Demonstration Facility would not be used for foraging by marine birds (Appendix 7: Envirosphere 2009c). Marine birds and coastal waterfowl occurring in the study area can be expected to forage throughout Minas Passage, including in salt marshes at the Project site and west of the mouth of Mill River. Only relatively low densities are likely to occur however, relative to the use of coastal environments where more extensive marshes occur. Local population size in relation to the population numbers of these species in Minas Basin and Inner Bay of Fundy are small, and therefore the likelihood of interactions with the Project is small. Based on the present scenario for the MCT generator, there will be a visible portion of the turbine's support structure projecting above the sea surface. The surface structure will be relatively small (approximately 15 m x 15 m x 4 m) and will extend approximately 21.5 m above sea level at low tide. It is anticipated that marine birds will land on rather than strike the surface piercing structure, as they are well adapted to the presence of anthropogenic objects. As surface piercing structures have not been designed to allow birds to slide off them, it is considered unlikely that the presence of such structures would prevent that habitat (landing on anthropogenic edifices) from continuing (Appendix 7: Envirosphere 2009c). The area to be occupied by the surface piercing structure will be insignificant in relation to the area of available habitat in the Minas Passage or the Minas Basin as a whole and in addition, there is no information to suggest that large numbers of marine birds are regularly present in this area of the Passage.

Vessel traffic associated with all phases of the proposed Project (*i.e.,* construction, operation, decommissioning) has the potential to either draw or deter marine birds depending on the type of activity occurring. The concern related to the attraction of marine birds to vessel traffic is the increased likelihood of collision, thereby increasing the risk of marine bird mortality and injury from vessel collisions; however such events are expected to be rare. It is anticipated that marine birds will land on rather than strike Project-related vessels as they are well adapted to the presence of moving anthropogenic objects and are known to land on boats and buoys (Appendix 7: Envirosphere 2009c). The likelihood of vessel collisions with marine birds will be reduced by several mitigation measures including maintaining low navigational speeds on fixed routes.

Some species of marine birds are attracted to or are particularly sensitive to the bright lights of marine vessels. Certain marine birds may be attracted to such lighting associated with the operation of vessels at night, which would further increase the risk of collisions. Additional lighting associated with the increased vessel traffic may cause degradation of habitat quality; however it will be minimal in relation to the amount of available habitat in the Minas Passage and the Minas Basin as a whole and will be temporary. Marine birds may also be attracted to lighting at the land-based facility. This issue has been discussed for terrestrial birds in Section 6.7, Terrestrial Wildlife and Wildlife Habitat, including mitigation strategies for reducing the effects of lighting on birds. It is recommended that crews' onboard Project vessels monitor the vessel decks for evidence of bird collisions, particularly during night activities. Consultations will be initiated with CWS and appropriate mitigation developed and implemented should there be regular reoccurrence of collision incidents or if lighting becomes a problem in attracting marine birds. Details of such monitoring programs will be further developed in support of the Project-specific EMP and will include requirements regarding frequency, timing, qualifications, notification, and maintaining records of monitoring.

Noise produced by marine vessels may cause marine birds to temporarily avoid the immediate Project area. Noise generated by vessel traffic will vary depending on the activity and the vessels used. Marine construction (and decommissioning) activities will require large vessels and barges for turbine deployment and cable installation. Activities are expected to be of short duration (*i.e.,* days) and intermittent given the proposed schedule. Vessel traffic during operations and monitoring is also expected to be of short duration and intermittent, and will use smaller vessels.

In addition to noise produced by marine vessels, noise associated with turbine device and cable installation or decommissioning may disrupt marine birds causing them to temporarily avoid the particular work area. Shorebirds can be disturbed by human activity during critical migratory periods. The most important period is the migration of the semipalmated sandpiper, which takes place in July - August, although some shorebird migrations extend through to November. The shoreline is generally unsuitable for shorebirds, in particular because of the absence of key food organisms, so they would not be particularly likely to occur at the site, and the disruption of their activities would not have a significant impact on feeding activity as a whole. In addition, the activities which take place at the site during cable installation occupy only a small portion of the beach, compared to the beach area as a whole. Furthermore, the duration of the activity is expected to be limited to 7 - 10 days for installation of all three cables. As such, the potential effect is anticipated to be not significant.

Underwater noise from marine vessels and from the operation of the turbine devices will not result in harm to marine birds; however, the noise and intermittent presence of vessels during all Project phases may cause marine birds to temporarily avoid this particular area of the Minas Passage. Birds which will occur mostly near shore along the coast, on Black Rock and flying through the area, are quite tolerant of noise and activity. In the event that they were seriously disturbed during construction, avoidance would be temporary (Appendix 7: Envirosphere 2009c). This temporary change in habitat use is not likely to have significant effects of marine bird populations, particularly as marine birds in the Minas Passage are already subject to similar levels of noise from regular vessel traffic (*e.g.,* commercial fishing and industrial vessel traffic).

Construction, operation and decommissioning could potentially have indirect adverse effects on marine birds through a reduction in the quantity or availability of primary food sources. This may result from the removal of benthic habitat and communities, or by the localized and temporary degradation of marine habitat resulting from disturbance to the seabed causing elevated levels of suspended sediments in the water column. Elevated levels of suspended sediments may cause fish to temporarily avoid the immediate area of impact until suspended sediments return to baseline levels. Environmental effects of the proposed Project on Marine Benthos and Marine Fish are discussed in Sections 6.1 and 6.2 respectively and are considered to be insignificant. Affected benthic communities will regenerate within a few years post construction and all harmful alteration to fish habitat will be compensated as required under the *Fisheries Act*. No residual adverse effects to food sources of marine birds are anticipated.

Turbine operation could potentially result in changes to the patterns of sediment distribution, which in turn may have an environmental effect on marine fish and invertebrate species and therefore marine birds; however, this issue is not well understood. Most marine birds depend on marine fish species (including shellfish) as a primary food source. In the Minas Passage and in the Minas Basin as a whole, the principal marine birds are migratory shorebirds that arrive in large numbers near the end of summer to feed on the abundant benthic life of the exposed intertidal zones. The distribution and abundance of marine bird prey species are a function of sediment properties, which could potentially be changed as a consequence of tidal power development (*i.e.,* installation and operation of the turbine devices) (Jacques Whitford *et al.* 2008). Decrease in turbulence downstream of a turbine device as a result of energy conversion, may affect the availability of marine birds to obtain their food. As per the SEA and the Background Report, it is acknowledged that a demonstration scale project will not likely have any measurable effects on physical processes beyond the immediate area (OEER 2008), such that effects on marine birds resulting from changes in sediment distribution are not likely to be significant. Bird surveys carried out July 7 - 9, 2008 and October 1 - 3, 2008 observed limited numbers of marine birds (Section 3.2.8) and additional information will be gathered regarding the occurance and movements of marine birds in the Project area via opportunistic observations made during all marine construction, operation, and decommissioning activities in combination with scientific research. It is understood that NSDNR is concerned that commercial development of tidal turbines arrays could cause changes in sediment distribution in the Minas Basin, which could affect mud flat environments and the ecosystem which is critical to shorebird feeding during the migration period. This is an important consideration because of the overall importance of the area to the shorebird population. However, the proposed Demonstration Project is not anticipated to affect the current regime significantly, and consequently is not anticipated to affect the sedimentation distribution and mudflat ecosystem used by shorebirds.

In summary, there is expected to be some short-term, localized changes to marine bird habitat use in the Project area as a result of noise associated with vessel traffic, particularly for installation and decommissioning. Despite the increase in vessel traffic, the risk of direct mortality from collisions for marine birds is considered to be extremely low. Additionally, installation of turbine devices and cables is not expected to have substantive residual effects on food sources or marine habitat for marine birds. By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine birds within the Project area or vicinity (*i.e.,* Minas Passage).

6.4.5 Follow-up and Monitoring

Very little information exists regarding the effects of tidal energy generation on marine birds. According to the Background Report conducted in support of the SEA, understanding the direct and indirect effects of tidal power generation on migratory birds that feed on intertidal invertebrates is a major concern for (commercial) tidal development in the Minas Passage (Jacques Whitford *et al.* 2008). Changes in sediment distribution potentially resulting from the installation and operation of turbine devices may result in changes to invertebrate populations, which in turn may cause changes to marine bird distributions. An objective of the Demonstration Facility is to gather information that will serve to further evaluate the potential effect for a larger scale development. The monitoring program will include monitoring of currents around turbines (including a control point) and other related aspects, including video surveys for changes in sediment deposition, if and where possible. It is also recognized that large scale multi-year hydrodynamic modeling assessment will be required to support future commercialization.

In addition to monitoring programs to be implemented during the operation phase of the Project, additional information related to the occurrence and movements of marine birds in the Project area will be gathered via opportunistic observations made during all marine construction, operation, and decommissioning activities in combination with scientific research. This will ensure that the frequency and species distribution of marine birds in the Project area are well known prior to any future tidal energy development. FORCE will also work with local fishers to gather additional observation and behavioural data. As above, this monitoring information will be used to confirm the predictions made in this assessment and to further inform future commercial developers through modelling.

It is recommended that crews' onboard Project vessels monitor the vessel decks for evidence of bird collisions, particularly during night activities. Consultations will be initiated with CWS and appropriate mitigation developed and implemented should there be regular reoccurrence of collision incidents or if lighting becomes a problem for marine birds. Details of such monitoring programs will be further developed in support of the Project-specific EMP and will include requirements regarding frequency, timing, qualifications, notification, and maintaining records of monitoring.

6.4.6 Summary of Residual Environmental Effects Assessment

By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine mammals within the Project area or vicinity (*i.e.,* Minas Passage).

6.5 Marine Species at Risk

Marine species at Risk is retained as a VEC in consideration of the potential environmental effects of Project components and activities on existing populations of these species in Minas Passage. This VEC was selected to meet regulatory requirements and due to important ecological roles that marine species at risk play in the Bay of Fundy. Species at risk are also important indicators of ecosystem health and regional biodiversity in general. Atlantic Salmon of the Inner Bay of Fundy, for example, are of a unique Canadian lineage of all other populations globally. These species are also of public concern and socio-economic importance for the tourism industry in the Bay of Fundy (*e.g.,* whale watching, recreational fishing, art).

Marine Species considered at risk for the purpose of this assessment are those species that are known to occur or spend part of their lifecycle in the Minas Basin (and would have to transit the Minas Passage), and that have been identified by federal or provincial agencies as being endangered, threatened, rare, special concern, or otherwise conservation concern. Marine species at Risk include Inner Bay of Fundy Atlantic

Salmon (*Salmo salar*), striped bass (*Morone saxatilis*), leatherback sea turtle (*Dermochelys coriacea*), harbour porpose (*Phocoena phocoena*), North Atlantic right whale (*Eubalaena glacialis*), finback whale (*Balaenoptera physalus*), American eel (*Anguilla rostrata*) and the porbeagle shark (*Lamna nasus*).

Marine Mammals and Marine Fish in general exhibit similar interactions and potential concerns with the Project are of importance to both groups. Impacts to Marine Fish are described in Section 6.2 while impacts to Marine Mammals are described in Section 6.3.

6.5.1 Boundaries

Spatially, the interaction between marine species at risk and the Demonstration Project is limited to the Project footprint, where activities associated with site preparation and construction, operation, accidents, malfunctions and unplanned events could potentially result in environmental effects on marine species at risk. The environmental effects of the loss of members of a rare population are assessed within the context of the regional biogeoclimatic zones that the species is found in.

The temporal boundaries of the Project include the periods of construction, operation, maintenance and decommissioning. Marine species at risk can be affected by Project activities any time of year. The temporal boundaries also include seasonal patterns and movements of different marine species, including breeding seasons and particular times of year when these species are most likely to be present in the Minas Basin or most-likely to have migrated out of the basin.

SARA provides legal protection for some rare marine species that have been proclaimed as endangered, rare, or vulnerable under the *Act*. The Nova Scotia *Endangered Species Act* offers additional legal protection to some rare species that have been proclaimed as endangered, rare, special concern or vulnerable under the *Act*. There are different levels of protection afforded to a species within these *Acts* depending upon the species rarity ranking and only those species currently listed in Schedule 1 of *SARA* are protected by that *Act*. Those species designated as “Species of Special Concern” are not protected by the prohibitions of *SARA*, but do require that provincial or regional management plans be developed to protect the species within a specified timeframe.

Information regarding the marine at-risk species within the Project footprint was derived from existing literature and data sources and limited field surveys. Existing data sources included an ACCDC rare species search for an area extending 10 km around the Project area. This data combined with habitat information for the proposed Facility and cable corridor route was used to help predict which species at risk may be present onsite.

6.5.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on all marine species at risk as listed in Schedule 1 of *SARA* as “Extirpated”, “Endangered” or “Threatened” or listed by the Nova Scotia *Endangered Species Act* as “Endangered” or “Threatened”, is defined as a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA*, or in contravention of any of the prohibitions stated in Section 13 of the Nova Scotia *Endangered Species Act*.

A **significant** adverse effect on marine species at risk but not under the protection of *SARA* or the Nova Scotia *Endangered Species Act* (*i.e.,* listed in *SARA* but not as “Extirpated”, “Endangered” or “Threatened” in Schedule 1; listed as “Species of Special Concern” within Schedule 1 of *SARA*; or ranked as “S1”, “S2”, or “S3” by ACCDC and also ranked “red” or “yellow” by NSDNR) is defined as an alteration of marine habitat physically, chemically, or biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a viable population that is dependent upon that habitat, such that the likelihood of the long-term survival of these population(s) is substantially reduced, the direct mortality of individuals or communities such that the likelihood of the long-term survival of these population(s) is substantially reduced, or in the case of marine species at risk listed in Schedule 1 of *SARA*, noncompliance with the objectives of management plans (developed as a result of Section 65 of *SARA*) that are in place at the time of relevant activities.

A **positive** effect on marine species at risk is defined as an increase in populations and/or diversity of species at risk, or an enhancement in the quality of critical habitat for species at risk.

6.5.3 Potential Issues, Interactions and Concerns

Potential interactions between the Project and marine species at risk relate primarily to:

- Mortality due to vessel strikes;
- Disturbance caused by the presence of the turbines and installation and monitoring equipment and vessels, particularly with regard to collisions;
- Noise and vibration generated by the turbines during operation leading to masking of cetacean vocalization; temporary threshold shift or hearing impairment; behavioural effects (*e.g.*, avoidance, changes in migration, or reproductive and feeding behaviors); or physical injury;
- Indirect effects through changes in prey distribution and abundance; and
- Accidental spills leading to potential contamination of species at risk (addressed in Section 7.0, Accidents, Malfunctions, and Unplanned Events).

The Project will involve the use of large barges and vessels during the construction phase for the deployment of the turbines and installation of the cables. Vessel traffic will be limited during the operations phase to small and medium sized vessels (*e.g.,* fishing vessels) used for various monitoring programs. Vessel traffic during decommissioning is expected to be similar to the construction phase. The increased vessel traffic in the Minas Passage (above existing commercial fishing and industrial vessel traffic) increases the potential for vessel collisions. Also, the increase vessel traffic increases the noise level in the Passage.

Installation of the MCT turbine may involve drilling for the installation of the foundation structure. This activity will result in increased noise and increased turbidity which has the potential to interact with marine species at risk. In addition to the potential interactions associated with vessel traffic, the presence of the turbines and the noise emissions from their operation has the potential to cause direct or indirect effects to marine species at risk.

6.5.4 Analysis, Mitigation and Residual Environmental Effects Prediction

6.5.4.1 *Cetacean Species at Risk: North Atlantic Right Whale, Finback Whale, Harbour Porpoise and Porbeagle Shark*

The North Atlantic right whale, *Eubalaena glacialis* is fragile in that the species is slow to mature, reproduces infrequently and at a low rate, and has been slow to recover despite having been protected for 60 years (Natureserve 2009). Two thirds of the entire population inhabit Canadian waters in summer and early fall months (DFO 2009). The outer Bay of Fundy is an essential habitat of the North Atlantic right whale

(Woodley and Gaskin 1996), with critical habitat including a conservation refuge near Grand Manan Island (DFO 2009).

Feeding finback (*Balaenoptera physalus)* and right whales are locally abundant in the Bay of Fundy in late summer and fall (Woodley and Gaskin 1996), especially in August and September when they are attracted to copepod populations (COSEWIC 2009). Finback whales occur in greater concentrations in the Bay of Fundy also earlier in the summer, beginning in June, when they follow concentrations of euphausiids, copepods and some small fish into shallower waters with high topographic relief (COSEWIC 2005; Woodley and Gaskin 1996), but are also observed in the area throughout winter. Finback Whales have a 2-year breeding cycle and relatively low reproductive rates.

Harbour porpoise (*Phocoena phocoena*) distributions concentrate in shallower waters (*i.e.,* < 150m deep) in the Bay of Fundy throughout the summer, where they follow prey species. Adults feed largely on Atlantic herring (Recchia and Reed 1989), and young feed largely on euphausiid crustaceans (Smith and Reed 1992). Some individuals may over winter in the Bay of Fundy. Harbour porpoise concentrate near the outer Bay of Fundy, with only a small proportion of this population inhabiting the Inner Bay (Gaskin 1992).

Porbeagle sharks (*Lamna nasus*) are a coastal and oceanic species, which can be found in waters less than 1 m in depth or as much as 700 m. They live in cold to temperate waters and can be found around the Scotian Shelf as well as in the Bay of Fundy during spring, summer and fall. Mating occurs from late September to November usually in areas such as the Grand Banks, south of Newfoundland and at the mouth of the Gulf of St. Lawrence area and pupping occurs later on in early April to June. Little is known where the shark overwinters. The population is listed by COSEWIC as endangered and is susceptible to overfishing especially due to a late maturation stage and low fertility rates.

Vessel strikes are the principal sources of mortality to North Atlantic Right whales (Kraus 1990, Knowlton *et. al*. 1994), and are cited as a threat to finbacks in COSEWIC's 2005 assessment and update status report on *Balaenoptera physalus* in Canada. Right whales may be particularly susceptible to vessel strikes as compared to other marine mammals as it has been suggested that the whales may be habituated to the sound of approaching vessels due to noise associated with shipping in the Atlantic (COSEWIC 2009) making the species less likely to avoid vessels at the Project area. The mechanisms these whales may use for avoiding collision with marine vessels are not clearly understood (DFO 2009). Right Whales have the ability to detect frequencies of sound produced by vessels; however, they may not always be able to hear the sound as it is often projected towards the rear and sides of oncoming vessels (Knowton and Brown 2007). The North Atlantic right whale has no natural predators and ships have been introduced to their habitat within short timeframe that does not permit evolutionary adaptation. Due to potential habituation to noise produced by vessels, they may not react to the sound of an approaching vessel (DFO 2009). In a study by Nowacek *et al.* (2004) these whales were observed to exhibit behavioural changes in response to species sound recordings associated with alarm but did not change their behaviour in response to vessel sounds.

There is lower likelihood for vessel collision with the much smaller, more agile harbour porpoise and porbeagle shark, and vessel collisions are highly unlikely with finback and right whales since these species primarily inhabit the outer Bay of Fundy, only infrequently visiting the Inner Bay. Should a whale be encountered during activities relating to construction, operation, maintenance or monitoring or decommissioning associated with the Project; several best management practices can be adopted to avoid injury or mortality to endangered marine mammals.

Faster travelling vessels are more likely to cause mortality or injury to whales. Collisions where vessel speeds were above 15 knots (28 km/hr) were found to be lethal to whales nearly 100% of the time, while collisions where vessels were travelling at lower speeds found lethality rates at less than 50% (Vanderlaan and Taggart 2007). Ships traveling at 14 knots or greater are more likely to cause lethal strikes to fin whales (Laist *et al.* 2001). Lethal collisions with right whales can occur even with small vessels; however ships greater than 80 m in length are more likely to cause fatality to fin whales. Vessel traffic speed should be limited as such to reduce the likelihood of fatal collisions. The likelihood of collision can also be significantly decreased by maintaining constant vessel speed and course through transit (Thomson *et al.* 2000). In addition, sufficient distance should be kept between vessels and whales whenever possible. In the United States, vessels may not approach individual Right Whales within 460 m with the exception of scientific research. Although no such legislation exists in Canada, a volunteer code of ethics was developed by NGO groups regarding the Bay of Fundy which suggests a whale or group of whales should not be approached by more than two vessels at one time, should not be approached nearer than 100 m, and should not be herded in the direction of fishing gear (Grand Manan Whale and Seabird Research Station 2009). Based on the improbability of an encounter with a right whale at the Project location, and given these preventative mitigation measures, the potential for significant adverse environmental effects on marine species at risk in considered not significant.

Fixed and moored structures typically become a focus for marine production (*e.g.,* reef effect) which further attracts marine life, including marine species at risk. To the extent that the turbines and their GBSs or foundations will be coated with an antifouling coating, this effect is unlikely. Furthermore, given the high current velocities in the Project area, this effect is rendered unlikely. Cetaceans at risk are therefore not likely to be attracted to the turbines therefore the potential for collisions is very low.

Anthropogenic disturbance and habitat degradation can be considered threats to right whales and fin whales (DFO 2009; COSEWIC 2005). Habitat disturbances can come at the cost of decrease in reproductive success and increase in mortality for right whales (COSEWIC 2003). Installation of the MCT turbine may involve drilling for the installation of the foundation structure. This activity may have effects similar to dredging in that it will result in increased noise and increased turbidity which has the potential for interaction. Section 6.2 describes impacts to water quality and concludes no effects are anticipated. In addition, since right whales and fin whales primarily inhabit the outer Bay of Fundy, and harbour porpoises infrequently enter the Inner Bay, the potential for this interaction to occur is low.

Although natural background sound levels can be intense for periods of time, anthropogenic sound disturbance may reduce the ability of right whales to hear mating calls over long distances, potentially reducing reproductive opportunities (COSEWIC 2003). Behavioural disturbance such as avoidance, hearing impairment, acoustic masking, and mortality can occur as a result of increased anthropogenic noise disturbance (Richardson *et al.* 1995). Increased noise levels can mask social interactions limiting the range for which whales (in general) can communicate and thereby also decreasing reproductive success (*e.g.,* beluga, Erber and Farmer 1998). Right whales can detect sound frequencies ranging from 12 Hz to 22 kHz, and produce sound at 50 Hz – 2 kHz (DFO 2009). Habituation, acoustic masking, avoidance, temporary hearing loss, and in extreme cases permanent hearing loss and physiological damage are potential issues for the fin whale with sound disturbances (Croll *et al.* 2001). Acoustic disturbances in relation to acoustic harassment devices at aquaculture stations have been studied to displace harbour porpoises from important habitat (Strong 1995).

Acoustic disturbance to harbour porpoises such as those previously documented near aquaculture sites are not likely to occur since acoustic productions from the turbine are incidental, not produced for the purpose of discouraging mammals from equipment, and sound emissions are not at the high frequencies used on harassment devices. Turbine generated noise and marine mammal interaction is discussed in Section 6.3. Based on previous work examining marine turbine devices, sound pressure and frequency levels are expected to occur at levels considerably below those which cause mortality, physical injury or hearing impairment to marine mammals in general. In addition, at distances beyond 200 m, turbine noise was difficult to identify above ambient tidal water flow noise. As such, behavioural interaction with marine species is considered to be limited to this range. Based on this distance of sound propagation, behavioural interactions would include avoidance rather than injury or mortality. In addition, since right whales and fin whales primarily inhabit the outer Bay of Fundy, potential for any interaction to occur is low. Monitoring (see below) should address various components of acoustic emissions, including sound propagation distance.

6.5.4.2 Fish Species at Risk; Inner Bay of Fundy Atlantic Salmon, Striped Bass, Shortnosed Sturgeon and Americal Eel

Inner Bay of Fundy Atlantic Salmon spawn in freshwater streams in October and November where they bury their eggs in gravel during the late fall. The eggs hatch in April and the alevins remain in the gravel for six weeks feeding off their yolk sac and then emerge as parr. The parr remain in freshwater for one to three years before migrating to sea as smolts at a size of 13 - 16 cm. Inner Bay of Fundy Atlantic Salmon grow and mature while migrating around the North Atlantic and then return to their natal rivers to spawn (Scott and Scott 1988). Most Inner Bay of Fundy Atlantic Salmon are thought to remain within the Bay of Fundy and Gulf of Maine throughout their life cycle (DFO 2008).

A science review of potential impacts of small-scale tidal generation projects in the Bay of Fundy felt that Inner Bay of Fundy Atlantic Salmon most likely to be found in the near surface waters based on available information, but agreed that vertical distribution of salmon in the water column was not well-documented (DFO 2008b). Marine habitat requirements are less understood as compared to inland habitat (COSEWIC 2006). The alteration of marine habitat, including altered migration routes, leading to depressed survival are threats to Inner Bay of Fundy Atlantic Salmon. The opinion of the Inner Bay of Fundy Working Group is that in 2003 there were less than 100 wild anadromous adult breeders spread across all the rivers in the Inner Bay of Fundy, with 50 – 70 being the most likely and 200 being an upper estimate (Appendix 9; CEF Consultants Inc. 2008; 2009).

The Shubenacadie River supports the only remaining spawning population of striped bass in the Bay of Fundy. No evidence of reproduction has been recorded in previously existing spawning populations of striped bass in the Annapolis or Saint John Rivers for about 30 years.

Striped bass were tracked using acoustic telemetry in the Miramichi River estuary during two consecutive spawning seasons in 2004 and 2005. In both years, prespawning striped bass staged in the lower and middle sections of the Miramichi River estuary downstream from the spawning area. Males and females moved in synchrony from the staging area to the spawning grounds in the Northwest Miramichi River (Douglas *et al.* 2009).

The shortnosed sturgeon is an amphidromous species, meaning they migrate between fresh and salt water regions. The Canadian population is however, restricted to the Saint John and Kennebecasis rivers in New Brunswick. They largely inhabit brackish and freshwater regions of this river system, often overwintering in the lower Saint John river in deeper saline regions and migrating upstream to reproduce in the spring (Dadswell 1979; COSEWIC 2005). While some species and other populations are more migratory, the Canadian population of shortnosed sturgeon have been shown by sonic tracking and genetic analysis to be largely isolated to this river system (COSEWIC 2005). As an estuarine species isolated to the Saint John and Kennebecassis Rivers and would be unlikely in the Minas Basin or Minas Passage (Dadswell 1979), however the species has been caught on rare occasions along the coast (Dadswell *et al.* 1984) of the Bay of Fundy. The potential for shortnose sturgeon to interact with the project is extremely unlikely due to its distribution.

American eels are commonly found in estuaries and coastal freshwater, American eel enter freshwater streams as small juveniles (elvers) where they mature. Some overwinter in estuaries while others migrate (August – December) to the mid-Atlantic ocean (Sargasso Sea) to spawn.

No effects are likely for Inner Bay of Fundy Atlantic Salmon, striped bass, shortnose sturgeon and American eel, since it is highly unlikely that a single or multiple individuals of the species would pass through the turbine and be injured by it. Unlike a hydro turbine, the fish have the whole cross section of the Minas Passage to move through, so the likelihood of passing through a single turbine or turbine array is improbable. Since the turbine devices and their GBSs or foundations will be coated with a biofouling coating or fouling release silicone based coating prior to deployment, the probability of collision is further decreased. Construction activities will have no effect on reproducing salmon or bass in freshwater rivers, where the species are most susceptible to anthropogenic disturbance since suitable habitat does not occur within the Project footprint. The only breeding location of striped bass occurs within the Schubenacadie River, and the nearest breeding locations for Inner Bay of Fundy Atlantic Salmon occur at the Diligent and Parrsboro Rivers (COSEWIC 2006). Localized disturbance of marine sediment during construction activities could temporarily affect habitat and food sources of salmon and bass, however this temporary localized effect would not be significant.

6.5.4.3 Herptile Species at Risk: Leatherback Sea Turtle (Dermochelys coriacea)

Leatherback sea turtles are a migratory species that occur along the Atlantic coast between June and November to feed, primarily on coelenterates, especially jellyfish (DFO 2006; COSEWIC 2001). Possible interactions between the species and Project include vessel or turbine collisions, and acoustic disturbance. The leatherback may be more likely to collide with ship traffic since they spend large amounts of time basking near the surface while feeding (NMFS 2001).

Leatherback turtles have been recorded off Nova Scotian waters and into the Bay of Fundy; however, concentrate off the southwest coast of Nova Scotia and Cape Breton. Leatherbacks are rarely observed in the Bay of Fundy. They are a largely pelagic species, visiting shallower waters for breeding or during feeding to follow coelenterate concentrations. Since breeding occurs in tropical and sub tropical areas, and high concentrations of prey species do not inhabit the inner Bay of Fundy near the Project location, the area does not meet suitable habitat requirements to support populations of leatherback sea turtles. Occurrences of the species are more likely incidental indicating it is highly unlikely that the leatherback turtle will be found in the Project area. As such, vessel collisions with turbines are extremely unlikely. Leatherbacks are relatively small and individuals would likely avoid the turbines. The sound emitted by the turbines would likely discourage leatherbacks from the immediate Project area. Potential effects to leatherbacks due to turbine are not considered significant since the turtle is unlikely to frequent the Project area and turbine sounds are difficult to distinguish from natural background levels beyond 200 m from the turbine.

6.5.5 Follow-up and Monitoring

FORCE and the device owners will implement a detailed monitoring program for the Demonstration Facility. The details of the program will be developed in consultation with relevant federal and provincial regulatory agencies and incorporated into the Environmental Management Plan for the Project.

Noise monitoring is anticipated to include:

- Collection of ambient noise levels in the area of the turbine devices;
- Collection of noise levels at reference sites for comparison;

- Collection of baseline noise levels at the project site for before/after construction;
- Collection of noise data for each of the turbines during regular operation;
- Collection of noise propagation data to determine distance of sound carried and model potential future noise propagation of a commercial facility; and
- Collection of noise data to determine interference potential with Cetacean communication.

The above information will be used to confirm the predictions made in this assessment related to the environmental effects of turbine noise emissions on Marine Species at Risk. It will also be used to model the potential cumulative noise emissions for potential future commercial tidal energy developments.

In addition to monitoring for noise, distribution of species in the Project area will be gathered via observations made during all marine construction, operation, and decommissioning activities. FORCE will also work with local fishers to gather additional observation data. Behavioural data should be observed and recorded. As above, this information will be used to confirm the predictions made in this assessment and to further inform future commercial developers.

6.5.6 Summary of Residual Environmental Effects Assessment

By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components will not cause significant adverse residual effects on Marine Species at Risk within the Project area or vicinity (*i.e.,* Minas Passage and Minas Basin).

6.6 Intertidal Environment

The intertidal environment has been selected as a VEC in consideration of the potential environmental effects of Project-related activities on the aquatic habitats present in the intertidal zone, namely, the salt marsh/barachois pond complex, including the small stream channel; the beach and beach ridge complex; and the fish habitat as well as the flora and fauna species that occupy them. This VEC was selected to meet various federal and provincial regulatory requirements and due to the important role that they play in the marine/terrestrial ecosystem. These habitats and species are also of public concern.

6.6.1 Boundaries

The spatial boundary for assessment of the intertidal environment includes all areas of the Project footprint and the habitats immediately adjacent to the footprint, or all areas of the intertidal environment that the proposed onshore facility and cable corridor will directly or indirectly disrupt, including portions of the barachois pond/salt marsh complex (the pond is considered fish habitat). Since the intertidal environment is a semi-permanent landscape feature it may interact with the Project on a year-round basis. Other temporal considerations include periods which are increasingly sensitive or critical times for some species, such as bird breeding periods (April to August for most bird species) and fish spawning periods.

Fish and fish habitat are protected under the federal *Fisheries Act* and the Nova Scotia *Environment Act*, while species at risk are protected under the federal *SARA* and the Nova Scotia *Endangered Species Act*. The *Policy for the Management of Fish Habitat*, developed in 1986 by DFO, applies to all projects, large and small, in or near watercourses that could alter, disrupt, or destroy fish habitat by any means (chemical, physical, or biological). The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The *Fisheries Act* is administered by DFO (except Section 36 which deals with the control of deleterious substances in fish habitat and is administered by Environment Canada in cooperation with DFO). DFO also works in collaboration with Nova Scotia Environment to protect fish and fish habitat. As a result, all activities that could potentially affect fish and fish habitat must be approved in advance by DFO and Nova Scotia Environment. In certain cases, approval may be required from Environment Canada.

Similarly, wetlands present in the intertidal environment are also a semi-permanent landscape feature and may interact with Project activities on a year-round basis. Specific Project construction activities may be short-term, but their effects on wetland habitat may persist throughout the year. As such, this assessment considers Project effects on the intertidal environment, including wetlands, year-round.

In the province of Nova Scotia, wetlands are protected by the provincial *EA* Regulations and the Activities Designation Regulations, which is outlined in the 2006 Operational Bulletin Respecting Alteration of Wetlands. Activities that directly or indirectly alter wetlands require a Water Approval under the Activities Designation Regulation of the NS*EA.* Similarly, installation of the temporary bridge and the cables across the small stream will also require a Water Approval pursuant to the Activities Designation Regulation.

DFO may also consider the disruption of fish habitat within the intertidal zone an activity that requires an authorization pursuant to Section 32 of the Fisheries Act for the harmful alteration, disruption or destruction of fish and fish habitat.

6.6.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on the intertidal environment is defined as a net loss of wetland function or habitat (*i.e.,* not compensated), as determined through a recognized wetland evaluation system; a change in surface water quantities that results in a long-term and/or permanent reduction of the resource to downstream locations; a Project-related change to surface water quality that could result in long-term and/or permanent impacts to aquatic life; or the net loss of fish habitat.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on the intertidal environment is defined as an enhancement in the quality of intertidal habitat available to wildlife species; an increase in species diversity; an increase in the area of wetland habitat; or an enhancement of the quality of surface water available to aquatic life.

6.6.3 Potential Issues, Interactions and Concerns

The potential interactions between Project-related activities and the intertidal environment are generally limited to the construction phase and the decommissioning phase, assuming that the cables are removed upon completion of the demonstration. Potential interactions include:

- Disturbance of salt marsh (wildlife) habitat during installation and removal of the cables through the intertidal environment;
- Disturbance of fish and fish habitat during cable installation and removal;
- Sedimentation from onshore construction; and
- Accidental spills leading to potential contamination of species at risk (addressed in Section 7.0, Accidents, Malfunctions, and Unplanned Events).

Installation of the cable through the intertidal zone is estimated to take approximately seven to ten days to complete. Work will begin with the removal of debris along the cable path and excavation and installation of anchors on the beach (at low tide) for the barge (Figure 2.5). This will also include installation of a temporary bridge across the small stream channel to enable equipment access to the shore.

Cable installation will involve the use of large equipment (*e.g.,* winch, barge, excavators). As described in Section 2.0, the cables will be pulled ashore and placed in a trench which will be subsequently backfilled using the excavated material. The use of such large equipment and the trenching and backfilling activities will disturb the habitats present in the intertidal zone and potentially down stream (*i.e.,* marine environment).

6.6.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Activities associated with the cable installation and removal could adversely affect species in the intertidal zone as a result of habitat disruption, noise, and related disturbance. As indicated in Section 3.0, wildlife (flora and fauna) in the intertidal zone in the Project area was found to have low species diversity and low population densities, thereby limiting the potential for adverse environmental effects. No rare species were identified. The Project footprint does not contain critical habitat for wildlife species. As such, the disruption of habitat associated with the Project will not threaten the existence of local wildlife populations.

Wetlands (salt marsh) are most sensitive to physical and noise disturbance during spring and early summer when they have thawed and are easily physically disturbed. During this time, birds and wildlife that use wetlands as breeding habitat are more susceptible to disturbance. Wetland wildlife habitat may also be more sensitive to construction activity in the spring and early fall when migrating waterbirds feed and rest in productive areas such as salt marshes. Shorebirds are expected to occur both inshore and offshore at the Project site, both through movements and foraging, as well as while resting during high tide periods. The densities for foraging and resting are expected to be low due to the absence of mudflats in the intertidal zone at the site. A small area of the inlet at the mouth of Mill River to the west of the Project site supports salt marsh and possibly mud flat areas at low tide, which may be frequented by and support small numbers of shorebirds. Cable installation through the intertidal zone is scheduled to take place between August 15 and September 30, 2010.

Cable installation activities may occur during migration season of shorebirds. However, given the relative short duration of activity (*i.e.,* 7 - 10 days) compared to duration of the migration season (*i.e.,* 4 - 5 months), the limited affected area, the unsuitable environment for foraging (*i.e.,* gravel beach), and the relatively small contribution the beach makes to shorebird feeding compared with other beach and intertidal areas in Minas Basin as a whole on both spring and fall migrations, the potential environmental effect is considered to be not significant. It should be noted that shorebirds presently occupy and feed in areas affected by human development (*e.g.,* mudflat environments adjacent to Minas Basin including coastal communities such as Wolfville and Windsor) and roost in dykeland areas where farming is taking place.

Equipment travel in the intertidal zone has the potential to disrupt habitat and cause rutting. As such, equipment travel will be limited to only those areas where excavation is required for installation/removal of the anchors and installation of the cables. Equipment travel in the intertidal zone will be minimized to the extent possible and any damage or rutting to the beach area will be repaired/stabilized.

As indicated in Section 2.2, every effort was made during the Project site/route selection process to avoid wetland habitat. Although wetland habitat could not be entirely avoided, all efforts to minimize the construction footprint through the salt marsh have and will be taken. Furthermore, wetland habitat will be restored immediately after installation of the cable. Restoration will include preservation and replacement of the vegetative/organic layer after backfilling and contouring. This will enable revegetation with native species over time.

To enable cable installation in the intertidal zone, a suitable temporary bridge structure (*i.e.,* spanning the entire channel) will be installed across the small stream to enable equipment access to the beach. The bridge will be installed immediately adjacent to the trench which will facilitate cable installation. Once the cables have been installed and the anchors removed, the bridge will be removed and the banks stabilized, as required.

Fish and fish habitat in the small stream and throughout the intertidal zone will be disrupted during installation (and removal) of the cables. Although very few species were observed, there is potential for additional species to be present. To minimize disruption and disturbance of fish and fish habitat, trenching and backfilling for cable installation through the intertidal zone (approximately 300 m) will be accomplished in a single day. Prior to trenching, the three cables will be pulled ashore and placed on the beach. At low tide, trenching will begin at the low tide mark and will work toward the shoreline. Trenching will not occur in open/flowing water. Once the trench is excavated, the cables will be placed approximately one metre apart and the trench will be immediately backfilled.

To minimize the potential adverse effects on fish and fish habitat during the crossing of the small stream, water will be diverted around the construction area using a dam and pump operation. Dams will be placed upstream and downstream of the trench area and water will be pumped around the site. Pumps will be equipped with fish screens in accordance with the Freshwater Intake End-of-Pipe Fish Screen Guidelines (DFO 1995). Prior to trenching through the stream, fish will be salvaged (by a qualified biologist) and released downstream. Trenching, cable installation, backfilling and channel stabilization/restoration will occur in a single day. Additional mitigative measures (*e.g.,* sediment and erosion control) will be provided in the Project EMP.

In addition to the direct effects associated with cable installation (and removal) through the intertidal zone, there is potential for indirect effects associated with onshore construction potentially resulting in erosion and downstream sedimentation. With the exception of the cable corridor, all onshore construction will be a minimum of 30 m from the high water mark. Surface water will be directed around the site to minimize erosion potential and construction-standard erosion and sediment controls will be installed to minimize offsite sedimentation. Additional and more specific mitigative measures will be provided in the Project EMP.

Specific Project activities in the intertidal zone will be of short-term duration (*i.e.,* intermittent and completed within less than 10 days), of limited extent (*i.e.,* limited to the cable trench area and barge anchor area), and all disturbed areas will be restored to their original condition, to the extent possible, immediately upon installation of the cables. It is acknowledged that the effects of the activities on the salt marsh wetland habitat may persist throughout the year, and potentially into the next growing season. Given the high tidal energy, open coastline and winter ice, the area is regularly subject to a great degree of natural disturbance. In consideration of the above, the limited disturbance associated with the Project is not considered to result in a significant adverse environmental effect.

FORCE will make application for all necessary approvals (*i.e.,* NSE Water Approvals for the stream crossing and alteration of the wetland, HADD Authorization and *Beaches Act* Permit) and will, if granted, comply with all conditions of approval throughout all Project phases.

6.6.5 Follow-up and Monitoring

The wildlife in the intertidal zone in the Project area was found to have low species diversity and low population densities. Given that the field surveys were conducted in the fall of 2008, it is acknowledged that there is potential that not all flora and fauna species that inhabit or migrate through the area were identified. Additional field surveys are proposed for the spring and summer of 2009 in an effort to capture any additional species. The results of the spring field surveys will be provided to the regulatory agencies. In the event that any rare species or species of conservation concern are identified, FORCE will work with NSE, NSDNR, and/or DFO and EC regarding the need for and development of appropriate mitigative measures.

As previously indicated, a provincial Water Approval pursuant to the Activities Designation Regulations is required for alteration of the salt marsh which will occur for the installation of the cable. During this provincial permitting process, NSE and NSDNR will determine the level of compensation, if any, that may be required. If required, FORCE, in consultation with NSE and NSDNR will develop a wetland compensation plan that will be implemented to ensure no net loss of wetland function. This will include a follow-up monitoring plan to monitor the effectiveness of wetland compensation project(s). Furthermore, if federal funding is provided for this Project, the federal Policy on Wetland Conservation will apply and CWS wil be included in the consultation and development of the compensation and monitoring plans.

6.6.6 Summary of Residual Environmental Effects Assessment

By following the above mitigative measures, standard construction practices, and available guidelines, Project-related activities are not likely to cause significant adverse residual environmental effects on intertidal environment within the Project area.

Accidents, malfunctions and unplanned events are assessed in Section 7.0 and cumulative environmental effects are assessed in Section 8.0.

6.7 Terrestrial Wildlife and Wildlife Habitat

Terrestrial Wildlife and Wildlife Habitat is selected as a VEC in consideration of the potential environmental effects of Project components and Project-related activities on existing species and their habitats in the Project area. This VEC was selected due to the potential for elements of native biodiversity and habitats that support unique assemblages of flora and fauna.

This VEC includes all terrestrial mammals, birds and herpetiles[1] (amphibians and reptiles) that may interact with the Project, as will as habitat that is important to wildlife species. Certain species, such as raptors, are generally sensitive to anthropogenic disturbances, especially during breeding periods. Environmental effects to bird species that depend primarily on marine habitats have been assessed in Section 6.4, Marine Birds. Rare terrestrial and marine species are discussed in Sections 6.5 and 6.8 respectively.

6.7.1 Boundaries

The spatial boundary for assessment of wildlife and wildlife habitat includes all areas of the terrestrial environment that the proposed onshore facility will physically disrupt, as well as a buffer zone which extends out to 500 m from these disturbed areas, in order to account for disturbance to wildlife. This reflects the reality that rare or sensitive wildlife and bird species may be present at any location within this spatial

[1] *Also spelled "herptile"*

boundary. Birds are sensitive to disturbance near nesting sites and any disturbance (including noise) can cause adverse effects.

The temporal boundary for the assessment of wildlife and wildlife habitat varies according to the Project component. A rare plant will always be present creating continual opportunity for Project interactions. In addition, interactions may be more severe at times such as spring, when the ground is soft. Some species are migratory and only present at certain times of year or during a critical point in their lifecycle.

Temporal boundaries for birds vary by species. Many bird species are migratory while some species do not travel far from specific areas (resident). The breeding season (April 1st to August 15th) is generally the most critical time period for birds, since birds are especially sensitive to habitat destruction and disturbance during breeding season: eggs and nestlings cannot avoid areas of disturbance and adults may abandon nest sites in response to noise or visual stimulus.

The *MBCA* administered by CWS protects all migratory bird species in Canada, prohibiting the killing, injuring or harassing of migratory birds, or the destruction of their eggs or their young without a permit. The Nova Scotia *Wildlife Act* and Regulations protect all non-game bird species not considered pests, while non-migratory game birds are protected (outside of hunting seasons) as defined by NSDNR. Game birds are under the management NSDNR.

Terrestrial herpetiles and mammals of the Project area are generally non-migratory, and undertake only seasonal movements. Therefore, herpetile and mammal species found in the Project area are likely vulnerable to Project related impacts throughout the year. Some species are particularly sensitive to disturbance at certain times of year. Animals that undergo extended winter sleep are sensitive to physical disturbance of habitat during the winter months due to the fact that they have no ability to avoid disturbance and are in a state of physiological stress. Many species of mammals and all herpetile species become inactive for the winter months, with some species entering into a state of hibernation.

All mammal species not designated as game animals or other harvestable wildlife under the provincial *Wildlife Act* and Regulations are protected year round, while game and furbearing animals are protected (outside of hunting seasons) as defined by NSDNR. Harvestable mammals are under the management of NSDNR.

Most species of amphibians congregate, mate and lay eggs in aquatic habitats during the spring, such that their eggs and larvae are present in watercourses during the spring and summer months.

Herpetiles which are hunted for food are protected (outside of hunting seasons) as defined by NSDNR. These include species such as bullfrogs and snapping turtles. Other herpetile species of no special status are not legislatively protected unless they are found in a protected area, such as a provincial park.

Bird, herpetile and mammal species at risk are protected by *SARA* and the Nova Scotia *Endangered Species Act*. Information regarding wildlife species and habitats within the Project area was derived primarily from field surveys and additional information was obtained from desktop review of existing literature and technical reports. Information is sparse regarding the distribution and population parameters of some wildlife species in Nova Scotia, particularly for small mammals including bats.

Field data collected specifically in support of this assessment (October 2008), existing data, and professional knowledge of site specific environmental conditions and Project activities, allow for an effective assessment of potential effects on wildlife and wildlife habitat. The entire terrestrial footprint was surveyed due to the small size. All parts of the site were examined from the West Bay Road down to the shore. No quantitative sampling was performed. Further terrestrial vegetation programs will be undertaken in June and August 2009 (early and late vegetation surveys) and the results provided to NSDNR. Should any listed species be determined to be present on the Project site as a result of this survey, mitigation (including avoidance where required by legislation) will be undertaken in consultation with NSDNR.

6.7.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on wildlife and wildlife habitat is defined as a decline or change in abundance or distribution of the population over one or more generations, such that natural recruitment may not re-establish the population to its original level, or avoidance of the area becomes permanent; a serious injury to or the loss of one or more individuals from within a population of a species having special conservation status; or any substantial change in distribution, migration or behavioural patterns, or the loss of critical habitat.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on wildlife and wildlife habitat is defined as an enhancement in the quality and/or extent of habitat, such that an increase is evident in the abundance of species relying on that habitat; or an enhancement in the quality of critical habitat for species of special concern.

6.7.3 Potential Issues, Interactions and Concerns

Despite the current use of the property for residential purposes, a number of activities (*i.e.,* clearing and grubbing) related to the construction of the land-based facilities and cable corridor could interact with wildlife and wildlife habitat. Potential effects on wildlife during the construction phase of the Project include fragmentation, habitat loss, direct mortality, and noise and related disturbance resulting from the presence of humans.

Fragmentation is the division or partitioning of habitats into isolated units, where there is some mechanism, such as human presence, that impedes or thwarts the exchange of wildlife between the units of habitat. Fragmented wildlife populations will have a lowered effective population number, resulting in populations that are more likely to decline as a result of natural or anthropogenic stressors, as well as populations that have a loss of fitness potential due to genetic homogeneity.

Linear developments such as cable corridors have the potential to fragment natural habitats and the proposed cable corridor for the Demonstration Facility will contribute to temporary local habitat fragmentation, particularly during the first few years of its existence. Once the cable is installed, initially there will be little vegetation on the corridor, which may make it difficult for small mammals and some insects to move from one side to the other, however, vegetation cover including tall shrub species will be allowed to grow over the cable corridor, effectively facilitating wildlife in crossing the corridor. The 30 m long cable corridor will pass through hay fields and old fields, vegetated escarpments, dense growths of alders and rose bushes covering approximately 0.15 ha, before passing through the intertidal zone. In these areas, the proposed corridor will likely contribute to temporary localized habitat fragmentation. Human presence and noise associated with the construction of the land-based Project components may temporarily discourage wildlife species, especially large mammals, from crossing the cable corridor. This interaction will be localized and of short duration. Once the construction phase of the Project is complete the presence of humans and human activity is expected to return to current levels.

Small wildlife species are known to stay in close proximity to vegetative cover when exposed to high levels of noise. This makes them increasingly susceptible to mortality and injury from the heavy equipment used during site preparation of the cable corridor and other land-based facilities. It is anticipated that localized and limited direct mortality of small wildlife such as rodents and herpetiles within the Project footprint is likely to occur during the construction phase of the Project. In addition to the 0.15 ha required to allow construction of the cable corridor, approximately 2 ha of land on a rectangular, gradually sloping plateau (a combination of old fields and hay fields, connected by grassed walking trails), will require site preparation to allow construction of the onshore facility/substation, cable vault and parking area. The onshore facilities and associated parking lot will occupy only a very small percentage of the available land, and ecosystems at the site and once completed, will provide alternate habitat for some small wildlife species.

It is unlikely that large and medium sized mammals will suffer direct mortality as a result of site preparation activities, as they would flee the area in response to human presence and noise. This type of avoidance behaviour by mammals has the potential to result in changes in normal movements, migrations or other life history processes of the species in certain situations. Impacts of avoidance behaviour for the proposed Project would only be temporary; as mammals would likely return to adjacent habitats after Project construction is complete and there is an absence of noise and human presence. Wildlife species in hibernation have a heightened sensitivity to disturbance during construction activities. Some species of wildlife (*e.g.,* herpetiles, American black bear, certain species of bats and rodents) go through prolonged periods of sleep or hibernation during winter months but it should be noted that no construction is planned for winter.

The nesting season for birds is generally the most critical life history stage for birds, largely because eggs and nestlings cannot move from any source of disturbance. Eggs and nestlings located in areas to be cleared for land-based Project components would likely be destroyed, if present. The effects of human presence and noise on breeding adult birds may also result in nest desertion, which in tern may result in exposure of hatchlings and eggs, and increased predation. Direct mortality or injury of adult birds is unlikely during construction activities as they would be expected to flee the area when exposed to high levels of noise. This type of avoidance behaviour by birds has the potential to result in changes in normal movements, migrations or other life history processes of the species in certain situations. Impacts of avoidance behaviour for the proposed Project would only be temporary; as birds would likely return to adjacent habitats after the construction phase of the Project is complete and there is an absence of noise and human presence.

During the operational life of the Demonstration Project, periodic vegetation control along the cable corridor and in the immediate vicinity of the land-based facilities may result in sporadic disturbance to wildlife due to noise and human presence. The maintenance of the corridor throughout the life of the Project will inhibit natural habitat succession. Woody vegetation types will be permitted to grow on the corridor but will be limited to a few meters in height. The cleared corridor may also increase the accessibility of wildlife habitat to the general public, thereby increasing the likelihood of continued disturbance to wildlife.

Vegetation management will be conducted by mechanical means, as herbicides used in vegetation control may be toxic to some wildlife species depending on concentrations. No herbicide use will be permitted.

6.7.4 Analysis, Mitigation and Residual Environmental Effects Prediction

A number of activities associated with the construction of the cable corridor and land-based facilities (*i.e.,* clearing and grubbing) could interact with wildlife and wildlife habitat. Potential effects on wildlife during the construction phase of the Project include fragmentation, habitat loss, direct mortality, and noise and related disturbance resulting from the presence of humans.

The construction of the cable corridor will contribute to temporary local habitat fragmentation, particularly during the first few years following construction when there is no tall vegetation along the corridor, which may make it difficult for small mammals and some insects to move from one side to the other. Seed dispersal may initially be impeded since no vegetation is present on the corridor making transportation by animals difficult, and the width of the corridor may not be sufficient for wind dispersal. Human presence associated with construction on the corridor would temporarily discourage animals required for seed dispersal. Allowing natural regeneration of flora and encouraging regeneration of existing seedbanks over the cable corridor can mitigate effects of fragmentation for terrestrial species by providing a means of dispersal between habitats (effectively facilitating wildlife in crossing the corridor).

There are no rare mammal populations or areas of sensitive mammal habitat (*e.g.,* deer wintering areas) found in or near the Project area, and as such, the Project is not expected to have any adverse effects on those species. No mammals were recorded as being present in the study area at the time of the surveys; however, there is anecdotal information regarding deer droppings and sitings in the vicinity of the Project. These and other mammals found in or near the study area could be affected by the Project. Activities such as grading and construction of land-based facility will likely create localized auditory, olfactory and visual stimuli that may disturb larger mammals, resulting in habitat abandonment within and adjacent to the Project footprint. Impacts of abandonment/avoidance behaviour for the proposed Project would only be temporary; as large mammals would likely return to adjacent habitats after the construction phase of the Project is complete and there is an absence of noise and human presence.

Clearing and grubbing activities will result in the loss of cover that provides food and shelter for mammal and herpetile species. In addition, such activities may also result in the localized and limited mortality of small mammals (*e.g.,* rodents) and herpetiles (*e.g.,* snakes and amphibians). The Project footprint does not contain critical habitat for mammal or herpitile species and no individuals were observed at the time of the October, 2008 terrestrial surveys undertaken by Envirosphere Consultants Ltd. None of the mammal or herpetile species likely to inhabit the study area would be particularly sensitive to anthropogenic activities and all are considered to be relatively common species. In addition, herpetiles are unlikely to occur in large numbers at the site, due to its small footprint and absence of freshwater ponds nearby, and it is expected that some members of these species would occur in summer, having dispersed there from other areas. Given this, the limited loss of any individuals or the loss of habitat associated with the proposed Project will not threaten the existence of any local populations (Appendix 8: Envirosphere 2009d). To the extent possible, the area to be cleared and grubbed will be minimized in order to decrease the likelihood of disturbing species. Once construction is complete, these species would continue to be found around the proposed Project, having moved in from adjacent areas.

Construction on the Project site can adversely affect herpetile populations through temporary habitat fragmentation and adversely modifying (*e.g.,* through siltation) or removing key habitat features (*i.e.,* breeding sites), particularly during the first few years following construction when there is no tall vegetation along the corridor. Alternatively, construction activities can positively affect herpetile populations through the possible creation of habitat (road side ditch pools which can provide valuable amphibian breeding habitat) and the creation of habitat edges (favoured by certain species of snake). Vegetation cover including tall shrub species will be allowed to grow over the cable corridor, effectively facilitating herpetiles in crossing the corridor post-construction.

Site preparation activities will remove the vegetation and change the quality of habitat along the edges of the proposed cable corridor and land-based facilities. Vegetation and habitat within the Project footprint will be permanently altered, though re-growth or low growing species will be permitted within the corridor. Efforts will be made during detailed Project design to minimize the overall area to be cleared. Construction of the shore facility including buildings and parking areas will permanently remove only a very small percentage of the available terrestrial environment from use by wildlife. The cable trench area will be disturbed during construction, but once installed, the area will be backfilled, restored and stabilized to as close as practical to pre-construction conditions. The land-based facilities are proposed to be located on formerly cultivated lands which have been abandoned and are at an early successional stage. After construction and restoration, the lands will eventually re-colonize with native vegetation within a few growing seasons and will provide alternate habitat for some small wildlife species. Although habitat may be lost for a few mammals, herpetiles, etc., it will not be a major fraction of the area occupied by the population, and only common species are likely to occur. It is recommended that a variety of species of plants native to the general area be used in revegetation efforts, where needed.

Several species of rare plants may be present within the Project footprint based on habitat requirements. The presence or absence of these species will be confirmed during the June and August 2009 terrestrial surveys (refer to Section 6.5, Terrestrial Species at Risk) in order to ensure that the routing of the cable corridor and placement of land-based facilities would not adversely affect any rare plants that may be present. Results of the surveys will be provided to NSDNR and appropriate mitigation developed and implemented in consultation with NSDNR, if necessary.

Clearing and grubbing will result in the removal of trees, shrubs, vegetative ground cover, brush piles and dead falls which may provide nesting habitat for various bird species. The effects of clearing would be most severe when undertaken during the breeding season for most bird species, primarily from April 1st to August 15th. To ensure compliance with the *MBCA*, clearing will be conducted during the fall and winter months in order to avoid most of the adverse effects on nesting birds. Additionally the width of the cable corridor will be minimized to the extent practical in order to reduce the amount of habitat lost. Should clearing be required prior to August 15th, the Project area will be surveyed for breeding activities, and nests in particular, no more than one week before commencing Project activities. Any Project related activities which may impact nests or young will be avoided (vegetated buffer zone established) and activities coordinated to work around them until nesting is complete and chicks have naturally migrated from the area. These activities will not occur within a 30 m vegetated buffer zone surrounding the nest of any bird considered to be a species at risk.

There are a limited number of bird species that nest during the winter months. Additional mitigative measures requested by relevant regulatory authorities will be undertaken, as feasible, to address these species or any ground nesting species that could potentially be affected in the Project footprint after clearing.

Certain bird species may be attracted to Project lighting. In order to avoid drawing birds to the Project site, lighting utilized for the safety of Project employees will be shielded to only shine where it is needed, without compromising safety. Road and parking lot lighting will also be shielded so that little escapes into the sky and only falls where it is required. In general, exterior decorative lights such as spotlights and floodlights with a function of highlighting features of the land-based facility etc. will be avoided, or the time of their operation restricted to when only necessary to ensure safety, particularly during the migratory season for most birds, when the risk to birds is greatest.

According to ACCDC (2008) and available habitat requirements, the American peregrine falcon (which nests in the vicinity of cliffs at Cape Sharp 1.0 - 1.5 km east of the Project site) and the monarch butterfly were the only at risk species which occur or could potentially occur in the study area. In addition, one “yellow” listed species, the common loon, was recorded in the study area during the marine bird surveys undertaken in July and October 2008 by Envirosphere Consultants Ltd. This species is considered to be fairly common (S4) by ACCDC (ACCDC 2008). These species are discussed separately in Section 6.5, Terrestrial Species at Risk.

It is acknowledged that terrestrial surveying for flora and fauna undertaken in October 2008 would not have been conducted at the most ideal time to identify rare flora species, migratory and breeding birds. In addition to wildlife field survey work conducted in 2008, additional field surveys will be conducted in the spring and summer of 2009 and results provided to the appropriate regulatory authorities. The additional surveys will focus on priority species (*i.e.,* those that are recognized provincially or federally as endangered, threatened, vulnerable, or of special concern) and will be conducted during peak periods for optimal detection of the various priority wildlife species that have the potential to be present in the area of the Project. Priority species will be identified in accordance with the Standard Steps identified in the Guide to Addressing Wildlife and Habitat in an EA Registration Document (NSE 2008). All survey work will be undertaken by qualified biologists. Should any rare species be identified within the study area, appropriate mitigative measures will be implemented in consultation with the relevant regulators.

Clearing and grubbing have the potential to create habitat edge which has both positive and negative implications for bird species. Habitat edges typically support a large number of bird species and high densities, however, edges also typically attract generalist predator species such as coyotes (*Canis latrans*) and racoons (*Procyon lotor*). Clearing for the Demonstration Project is not likely to create a net gain of additional edge habitat, as the site is located along a coastal area that has been previously developed (along trails, along the scarp, and around the edge of the fields). The whole area (the coast) is an edge habitat; within that habitat there are smaller scale edge habitats (the borders of the fields, trails etc.). There are lots of all types of this habitat, such that the Project will affect only a small proportion of each type, and therefore the effect will be insignificant (Appendix 8: Envirosphere 2009d).

Mechanical clearing will be the preferred vegetation control method utilized during cable corridor and land-based facility maintenance. As noted, herbicides will not be used in vegetation control.

Maintenance clearing in these areas will be prioritized to occur outside of the breeding season for most species of birds (April 1st and August 15th). If maintenance clearing is required prior to August 15th, the Project area will be surveyed for breeding activities no more than one week prior to the beginning of Project activities. Any Project related activities which may impact nests or young will be avoided (vegetated buffer zone established) and activities coordinated to work around them until nesting is complete and chicks have naturally migrated from the area. These activities will not occur within a 30 m buffer zone surrounding the nest of any bird considered to be a species at risk.

With the mitigation methods provided and proper scheduling, no significant adverse residual environmental effects on wildlife and wildlife habitat due to construction, operation and maintenance activities are likely to occur.

6.7.5 Follow-up and Monitoring

June and August, 2009 terrestrial surveys will be conducted over the Project area to determine the presence or absence of rare flora species, mammals, herpetiles and birds. Results of the surveys will be provided to NSDNR and appropriate mitigation and follow up monitoring programs (if warranted) developed and implemented in consultation with NSDNR.

6.7.6 Summary of Residual Environmental Effects Assessment

With the mitigation methods provided and proper scheduling, no significant adverse residual environmental effects on wildlife and wildlife habitat due to construction, operational or maintenance activities are likely to occur. Conclusive information will be obtained from the June and August, 2009 terrestrial site surveys.

Accidents, malfunctions and unplanned events are assessed in Section 7.0 and cumulative environmental effects are assessed in Section 8.0.

6.8 Terrestrial Species at Risk

Terrestrial Species at Risk is retained as a VEC in consideration of potential environmental effects of Project components and Project-related activities on existing populations of these species and their habitats in the Project area. The VEC was selected to meet regulatory requirements and due to the potential for species of concern to inhabit the project. Species at risk are important indicators of ecosystem health and regional biodiversity and their preservation often ensures the preservation of rare habitats they are associated with.

Terrestrial Species at Risk includes species identified by federal or provincial agencies as being endangered, threatened, rare, special concern, or otherwise of conservation concern, and which have the potential to interact with the Project. This specifically includes flora, birds and a rare species of butterfly. Terrestrial species at risk are closely liked with other components of terrestrial ecosystem, discussed in Terrestrial Wildlife and Wildlife Habitat which are discussed in Section 6.7. Environmental effects to marine species at risk are discussed in Section 6.5.

6.8.1 Boundaries

Spatially, the interaction between terrestrial species at risk and the proposed Demonstration Facility is limited to the Project footprint, where activities associated with site preparation and construction, operation, accidents, malfunctions and unplanned events of the Project could potentially result in environmental effects on terrestrial species at risk, as well as a buffer zone which extends out to 500 m from these disturbed areas, in order to account for disturbance to wildlife. The environmental effects of the loss of a rare population are assessed within the context of the regional biogeoclimatic zones that the species is found in.

The temporal boundary for the assessment of terrestrial species at risk varies according to the component. A rare plant will always be present creating continual opportunity for Project interactions and in addition, interactions may be more severe at times such as spring, when the ground is soft. Some species at risk are migratory and are only present at certain times of year or during a critical point in their lifecycle. Generally, species at risk can be affected by Project activities any time of year, although certain activities (*e.g.,* clearing and vehicle movements on wetlands) may be conducted preferentially at times when the ground is frozen to minimize damage to root systems of plant species in areas not intended for grubbing.

Temporal boundaries for birds at risk vary by species. Many bird species are migratory while some species of birds do not regularly travel far from specific areas (resident). The breeding season (April to August) is generally the most critical time period for birds since breeding birds are especially sensitive to habitat destruction and disturbance, eggs and nestlings cannot avoid areas of disturbance and adults may abandon nest sites in response to a disturbance such as noise or visual stimulus.

The *MBCA* administered by CWS, protects all migratory bird species in Canada, prohibiting the killing, injuring or harassing of migratory birds, or the destruction of their eggs or their young without a permit. The Nova Scotia *Wildlife Act* and Regulations protect all non-game bird species not considered pests, while non-migratory game birds are protected (outside of hunting seasons) as defined by NSDNR. Game birds are under the management NSDNR.

The Nova Scotia *Endangered Species Act,* as well as *SARA,* serves to protect species at risk. There are different levels of protection afforded to a species within these *Acts* depending upon the species rarity ranking and only those species currently listed in Schedule 1 of *SARA* are protected by that *Act*. Those species designated as "Species of Special Concern" are not protected by the prohibitions of *SARA*, but do require that provincial or regional management plans be developed to protect the species within a specified timeframe.

For the most part, rare flora species at most locations in Nova Scotia are not protected by law, however, the presence of rare vegetation is considered to be an environmental constraint in terms of the EA process. The degree to which rare vegetation may pose a constraint depends on the rarity of the species and their sensitivity to Project activities.

Three species of mammals are protected under the Nova Scotia *Endangered Species Act*. Herpetiles species are not legislatively protected unless they are found in a protected area such as a provincial park or are listed as a rare or endangered species under either *SARA* or the Nova Scotia *Endangered Species Act*.

Information regarding the at-risk species within the Project footprint was derived from existing literature, existing data sources and field surveys. Existing data sources included an ACCDC rare species search for an area extending 10 km around the Project area. This data combined with habitat information for the proposed facility and cable corridor route was used to help predict which species at risk may be present onsite and identify habitat types that should be searched during the 2009 field surveys.

Field surveys were conducted in early October to determine if any uncommon, rare or sensitive species were present along the proposed facility and cable corridor route. The entire terrestrial footprint was surveyed due to the small size. All parts of the site were examined from the West Bay Road down to the shore. No quantitative sampling was performed. In the instance any uncommon, rare or sensitive species are encountered during the 2009 surveys, the location will be recorded with a global positioning system and the number of individuals present recorded.

Most of the rare plant species found in NS cannot be reliably identified outside of the growing season and many species can only be reliably identified while in flower or fruit, which may limit the time period during which they can be detected. Similarly, the breeding status of most NS bird species at particular sites cannot be reliably determined outside their breeding season, during which they are readily detectable by song and other behaviours and are actively defending territories. It must be noted that field surveys were conducted in early October, and no conclusions may be drawn as to the presence or absence of listed species more easily seen or identified in other seasons. Further terrestrial vegetation programs will be executed in 2009, timed to capture periods when listed species would be most easily identified, and the results provided to NSDNR.

6.8.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on all species as risk as listed in Schedule 1 of *SARA* as "Extirpated", "Endangered" or "Threatened" or listed by the Nova Scotia *Endangered Species Act* as "Endangered" or "Threatened", is defined as a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA*, or in contravention of any of the prohibitions stated in Section 13 of the Nova Scotia *Endangered Species Act*.

A **significant** adverse effect on species at risk not under the protection of *SARA* or the Nova Scotia *Endangered Species Act* (*i.e.,* listed in *SARA* but not as "Extirpated", "Endangered" or "Threatened" in Schedule 1; listed as "Species of Special Concern" within Schedule 1 of *SARA*; or ranked as "S1", "S2", or "S3" by ACCDC and also ranked "red" or "yellow" by NSDNR is defined as an alteration of habitat physically, chemically, or biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a viable population that is dependent upon that habitat, such that the likelihood of the long-term survival of these population(s) is substantially reduced, the direct mortality of individuals or communities such that the likelihood of the long-term survival of these population(s) is substantially reduced, or in the case of species at risk listed in Schedule 1 of *SARA*, noncompliance with the objectives of management plans (developed as a result of Section 65 of *SARA*) that are in place at the time of relevant activities.

A **positive** effect on species at risk is defined as an increase in populations and/or diversity of species at risk, or an enhancement in the quality of critical habitat for species at risk.

6.8.3 Potential Issues, Interactions and Concerns

As noted above, the terrestrial species at risk that may be present on the Project site include five plants species, two bird species and the Monarch butterfly.

A number of the construction activities present the potential to impact of rare or uncommon species. Potential effects on terrestrial species at risk include direct mortality, or indirect mortality and population effects associated with components of habitat disturbance.

Clearing, grubbing and grading required for on site facility and cable corridor and trench construction could cause the destruction of rare plants on the project footprint. Alteration of hydrological regime and alteration of local freshwater marsh and saltwater marsh/barachois pond habitat through the sedimentation of watercourses or through runoff could adversely affect local rare plant populations through soil enrichment or by smothering plant communities. Since rare species may be sensitive to competition, changes to community structure related to the introduction of invasive species to the Project site during construction activities could impact local populations.

Temporary fragmentation has the potential to affect rare plant communities on site through impeding dispersal, and potentially making populations more susceptible to other effects of anthropogenic disturbance. Potential edge effects on habitat adjacent to the project footprint similarly have the potential to effect rare flora or fauna near the Project footprint.

Noise and physical disturbance created by machinery and human presence may lead to the temporary abandonment of peregrine nests on adjacent cliffs to the east, resulting in mortality of young.

Loss of monarch butterfly and common loon habitat associated with clearing of land for the Project footprint also presents potential interaction.

6.8.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Clearing and grubbing of 2.0 ha required for the on site facility and area required for the cable corridor could adversely affect terrestrial species at risk, if present. These activities could result in the removal of individual or populations of rare plant species inhabiting the site. Appropriate mitigation strategies will be developed and implemented in consultation with NSDNR, if necessary. Where economically and technically practical, the loss of rare populations could be mitigated by making alterations to the Project footprint so as to avoid locations of rare species.

Sediment transported from construction activities has the potential to smother species such as the short-awn foxtail (*Alopecurus aequalis)*, marsh bellflower (*Campanula aparinoides)*, fir club moss (*Huperzia selago)*, and Dudley's rush (*Juncus dudleyi*) which (if present) inhabit wet areas, potentially near on site wetlands such as the freshwater marsh and saltwater marsh/barachois pond complex. Alteration of hydrologic regime caused by anthropogenic disturbances such as land clearing, forestry and wetland alteration have been sited as the major source of sensitivity for rare Juncus *spp*. in Nova Scotia with similar habitat requirements

(COSEWIC 2004). Sedimentation can also shift plant community structure through increasing productivity. Since the short-awn foxtail is intolerant of competition from other plants (Roland and Zinck 1998), it may be particularly sensitive to changes in community structure.

Wetland systems are most susceptible to physical disturbances in the spring and summer when soils are thawed and vegetation exposed, and least susceptible to disturbances in winter. To mitigate effects, construction activities that would affect hydrological systems could be undertaken in winter. Excavation activities should include standard construction best management practices to control erosion and stabilize exposed slopes (*e.g.,* silt fences, hay bales, erosion control blankets, etc.).

Fragmentation resulting from land use conversion, and the linear development of a cable corridor could adversely effect rare plant populations. Fragmentation can affect dispersal and success of all rare species, however, the marsh bellflower is particularly sensitive to habitat fragmentation (Natureserve 2009). Smaller populations are more susceptible to fragmentation, and fragmented species have a lowered effective population number. Smaller populations are also less resilient of anthropogenic disturbances due to genetic homogeneity. Construction activities and a lack of vegetation on the corridor may initially make it difficult for small mammals and insects to cross (discussed in terrestrial wildlife and wildlife habitat, Section 6.7), thereby temporarily impeding dispersal mechanisms of rare plants across the corridor until the presence of human activity returns to baseline levels and the area is permitted to regenerate. The width of the corridor may additionally be insufficient for wind dispersal of rare plants.

The width of the corridor will be minimized to the extent practical to mitigate concerns with distance. Encouraging natural regeneration of existing seedbanks over the cable corridor will mitigate effects of temporary fragmentation for terrestrial species by providing means of mobility between unaltered habitats. In addition, since the area to be cleared for the Demonstration Project has been previously developed, site clearing impacts will be minimal making the temporary fragmentation effects also minimal in scale. Should the field studies conducted in June and August, 2009 determine the presence of marsh bellflower or other rare species spatially located such that the effects of fragmentation would be significant despite these mitigation effects, additional strategies will be developed and implemented in consultation with NSDNR.

Habitat along borders of the Project footprint will be subject to edge effects including alteration of microclimatic conditions. Changes in physical characteristics including light and humidity, and exposure to anthropogenic disturbance on edge could alter the suitability of habitat adjacent the Project footprint for rare species (if present) that inhabit these areas. However, since large portions of the Project footprint were previously developed, the site presently exhibits edge habitat and clearing for the Demonstration Facility is not likely to create a net gain of additional edge habitat.

Raptors, including the peregrine falcon *(Falco peregrinus anatum)*, are sensitive to anthropogenic disturbances particularly during the breeding season. Peregrine falcons nest in cliff ledges, tree hollows, open bogs, and occasionally large stick nests of other species (Natureserve 2009). Eggs are laid in April and young fledge within 49 days (SARA 2009). These habitat types do not exist within the Project area and so direct mortality of this species is not expected.

Adverse effects on peregrine falcons could occur indirectly, through disturbance related to construction activities on nearby nesting locations. Sensory disturbance including noise and visual presence of construction activities can result in permanent abandonment, or increased predation resulting in loss of individuals during temporary abandonment of nesting sites. Additionally, energy expenditures of birds are increased as a result of this stressor. The nesting territory defended by peregrine falcon is typically within a 1 km radius (SARA 2009).

Surveys will be undertaken in June and August 2009 to determine whether there are any nesting locations on site. Should any be identified within the study area, appropriate mitigative measures will be implemented in consultation with NSDNR. Construction activities should be conducted after August 15th so as to avoid breeding season, when the species is most vulnerable to anthropogenic disturbances. The presence of peregrine falcon nests on site could also be mitigated through alteration of the Project footprint to avoid nesting areas.

Maintenance clearing in the project area will be prioritized to occur outside of the breeding season for most species of birds (April 1st and August 15th). If maintenance clearing is required prior to August 15th, the Project area will be surveyed for breeding activities no more than one week prior to the beginning of Project activities. Should a nest be found during such surveys, no activities which may impact the young will be permitted within a 30 m buffer zone surrounding the nest.

The proposed nearshore and land-based facilities are approximately 1.2 km from a known pair of nesting peregrine falcons at Cape Sharp. Peregrine falcons forage within a 27 km radius, which could include the land-based facilities (SARA 2009). The birds are known to forage widely in the area and may even fly over the site on a regular basis. Habitat types used for falcon foraging that are found within the Project footprint include farmland, marshes, tidal flats and beaches (Natureserve 2009). Since rodents are among prey species of peregrine, their expected mortality due to the Project (described in Section 6.7) could have a limited impact on the peregrine falcon (Natureserve 2009). However, these effects are expected to be temporary, occurring during construction of the Project. Peregrine falcons are known to feed mainly on birds, rather than rodents. Any Project related effects to falcon foraging habitats are not expected to be significant.

Work on the cable installation including trenching may be within the line of sight and audible by the nesting peregrines, and efforts should be made to minimize exposure to the extent practical. Activities at the site will take place outside the nesting period for the falcons, which is from early April to the end of July, to the extent practical. Activities will be undertaken efficiently to minimize potential interactions and construction personnel will be limited to the area designated for construction. Operation of the interpretive center on shore will include measures to manage the number of visitors permitted on to the beach, if required. Guidelines will be established in consultation with wildlife biologists from NSDNR and/or CWS.

Vessels used for turbine installation will avoid, to the extent possible, the use of West Bay and the waters immediately beneath the cliffs at Cape Sharp in the April to late-July period to minimize potential effects on peregrine falcons.

Marine bird surveys undertaken in July and October of 2008 recorded one “yellow” listed species, the common loon (*Gavia immer*) in the study area, however, this species is considered to be fairly common (S4) by ACCDC. Since there are no freshwater lakes or suitable nesting habitat found near the Project footprint, no effects on loon habitat are predicted.

Destruction of habitat for the monarch butterfly *(Danaus plexippus*) could result in adverse population effects. Monarch butterfly habitat is composed of milkweed (*Asclepias* spp.) which is the primary food source and breeding habitat for the butterfly in North America. Milkweed was not observed during species inventory for the site, making the likelihood of interaction low. No effects on monarch butterfly are predicted.

6.8.5 Follow-up and Monitoring

The NSDNR habitat mapping database, ACCDC database, and on site field assessments were used to evaluate the presence or absence of terrestrial species at risk. These resources were used to determine a list of possible or likely occurrences of species within a 10 km radius of the study site. However, since the site field survey was conducted in early October when identification of many species would not be possible due to seasonality, no conclusions can be drawn about the presence of these species. The follow up studies to be conducted in June and August 2009 will conclusively address the presence of terrestrial species at risk on site. This information will be provided to NSDNR and used to assess issues, interactions, and concerns.

6.8.6 Summary of Residual Environmental Effects Assessment

By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on terrestrial species at risk within the Project area or vicinity (*i.e.,* Minas Passage and Minas Basin). Conclusive information will be obtained from the June and August, 2009 site surveys and provided to NSDNR to develop and implement appropriate mitigation in consultation with NSDNR, if necessary.

6.9 Recreational and Commercial Fishing

Commercial fisheries are considered a VEC for this assessment due to their importance for the local and regional economies and their importance to each individual fisher. Several commercial fisheries occur in the Minas Channel and Minas Passage although, with exception to lobster, they are peripheral to and generally less intensive than fisheries occurring in the Outer and Inner regions of the Bay of Fundy.

Lobster is the main commercial fishery in the Minas Passage/Minas Channel, which is included in the inner Bay of Fundy lobster management area (LFA 35). Eleven boats routinely fish in the study area and traps are set during the lobster season, which extends from March to July and October to December. Most fishing activity takes place along the Blomidon, Scots Bay and Parrsboro shores, and is concentrated near shore, although traps are occasionally set in deeper, higher-current areas (Appendix 9; CEF Consultants Inc. 2008; 2009).

The focus of this VEC is commercial fisheries, since there was no significant recreational fishing activity identified in the project area. Commercial aquaculture was not considered further since there are no existing or planned aquaculture operations in the vicinity of the Project area.

There are close linkages between the assessment of Commercial Fisheries and the environmental effects on Marine Benthos (Section 6.1) and Marine Fish and Water Quality (Section 6.2). A description of the current state of commercial fisheries in the area is provided in Section 3.4.5 Land and Resource Use.

6.9.1 Boundaries

For commercial fisheries, the general spatial boundary for the assessment considers the Minas Passage/Channel, the location of the proposed Demonstration Facility, and any other locations in the Minas Basin where the project may interact with commercial fishing activities. Commercial fishing activities undertaken outside of the Minas Channel are not considered to be within the spatial boundaries of the assessment. While it is recognized that there are ecological links between the Minas Channel and the rest of the Bay of Fundy (*e.g.,* species originating in the basin may be ordinarily carried out of the basin by currents to populate other areas of suitable habitat), it is reasonable to focus this assessment on areas of greatest potential for direct project interaction with the commercial fishery (*i.e.,* in the Minas Passage/Channel).

The temporal boundaries for the assessment of the commercial fisheries include the construction, operation and decommissioning phases of the Project. Temporal boundaries also consider time periods when fisheries are most active in the Project area (*i.e.*, during fishing seasons), as well as biologically sensitive time periods (*e.g.,* spawning) for individual species. Fisheries in the Minas Channel are generally limited to certain specified fishing seasons defined by DFO. Start and end dates of the fishing seasons for the species fished in the Minas Basin are included in Section 3.4.5.

Construction is anticipated to take place over several weeks beginning in October 2009 with the deployment of Nova Scotia Power Inc./OpenHydro turbine, followed by the installation of cables in the August/September 2010, and the deployment of the Clean Current and MBP&P/MCT turbines in September/October 2010 or possibly in 2011. The duration of construction activities is expected to total 12 - 14 weeks spread out for a two year time period, although not all of this time will be spent on the water in the deployment area. The installation of the subsea cables and turbine devices are tentatively scheduled to occur outside of the key commercial lobster fishing season. This schedule is subject to the availability of the subsea cables, turbine devices and deployment vessels. In the unanticipated event that the components are not available at the scheduled time; a contingency construction plan will be developed.

The commercial fisheries considered in this assessment are located within Fishing Division 4XR and LFA 35. These fisheries management units and assigned fishing licenses and seasons define the administrative boundaries, and DFO assumes responsibility for the management of fish stocks in these areas.

The protection of fishing resources generally falls under the federal *Fisheries Act* as protecting fish and fish habitat ultimately includes fisheries resources. Fisheries resources are also protected by legislated fishing quotas, fishing seasons and gear limitations. Commercial fisheries are the responsibility of DFO.

DFO catch data, research survey data, published literature, consultation with fishing associations and a 2009 study undertaken in support of the project by CEF Consultants Ltd. on fisheries landings, value and communities in the Minas Basin were the primary sources for information related to commercial fisheries. A technical limitation associated with information related to commercial fisheries is that the fishery landings statistics outlined in the CEF Fisheries Report (Appendix 9) are based on the port where the fish are landed, and do not indicate the specific geographical region where these fish were caught. As such, it is not clear what proportion of these recorded landings were actually captured in the Minas Passage. This is of particular importance when assessing any changes to landings and landed value that may occur as a result of the Project.

6.9.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on commercial fisheries is defined as one that is likely to cause any one or both of the following:

- An unmitigated or non-compensated net financial loss to Commercial Fisheries as a result of the Project. It is understood that a net financial loss must be discernable outside the range of normal inter-annual variation in landings experienced by fishers for a variety of non-Project related reasons.
- Uncompensated damage to fishing gear or vessels.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on commercial fisheries is defined as an enhancement of opportunities for commercial fisheries which results in an increase in harvests, revenues and/or profitability.

6.9.3 Potential Issues, Interactions and Concerns

Fishers in the Minas Passage area (mainly lobster fishers) expressed concerns about how the Project may affect their livelihood by restricting access to traditional fishing areas due to a fisheries exclusion zone around the turbines, loss or damage to gear due to snagging on cables or due to increased vessel traffic associated with project activities, and the loss of lobster resulting from changes to movements and behaviour due to effects from the Project such as noise and EMF.

The proposed fisheries/safety exclusion areas around the turbines will displace fishers from the affected area. There is a higher potential for the loss of fishing gear because of the turbines and cables if the fisheries exclusion zone and cable location coordinates and charting are not respected.

There is potential for interference with the movement of fishing vessels during the installation and removal phases of the Project, because the turbine deployment will require large barges, tugs and support vessels for cable laying and the possible use of a drilling ship if a piled support structure is used for the MBP&P/MCT turbine.

Vessels will also be required during the operational phase to undertake maintenance and monitoring activities; but these will consist of relatively small to medium size boats such as lobster fishing vessels. Additional vessels in the area increase the potential for vessel interaction with lobster fishing vessels, accidental discharges and increase noise level in the Passage.

The use of a surface piercing structure for the MBP&P/MCT turbine may affect ship navigation and increase the potential vessel collisions with the fixed structure. Furthermore, the installation of the MBP&P/MCT turbine may involve drilling for the installation of a pile foundation structure, resulting in increased noise levels and turbidity which has the potential to interact with fish.

The deployment of the GBSs for the turbines on the seabed may disturb and/or destroy lobsters and/or their habitat. The turbines and cables may affect fish behaviour and act as barriers to movement and migration of commercially important species due to their physical structure, noise and EMF effects.

6.9.4 Analysis, Mitigation and Residual Environmental Effects Prediction

There are no active commercial fisheries in the Project area, with the exception of the lobster fishery (CEF Consultants -Appendix 9; Atlantic Herring Co-op, Full Bay Scallop Association [Stewart pers. comm. 2009]; Scotia Fundy Mobile Gear Fishing Association [Giroux pers. comm., 2009]) The nearest herring weir is at Partridge Island, approximately 8 kilometres East of the Project area. The Heavy Current Fishers Association (HCFA), which represents the majority of the lobster fishers that fish in the Passage, indicated that there are 11 lobster fishers in the area. Of these 11, only nine actually fish in the surrounding areas of the Minas Channel, and not all are members of HFCA. The actual number of lobster fishers that operate in the Project area is difficult to quantify but would appear to be three to four fishers based on consultation with fishers. Much of the fishing activity in the Project area appears to occur near shore and around Black Rock.

No commercial Aboriginal fishing activity in the Project area was identified by either the Assembly of Mi'kmaq Chiefs of Nova Scotia or the Native Council of Nova Scotia. The Fort Folly First Nations from Dorchester, New Brunswick operates lobster fishing boats out of Parrsboro, but fish the Five Islands area of the Minas Basin, 24 km east of the Project area.

A fisheries/safety exclusion zone of 300 meters around each turbine has been proposed, which would result in the loss of less than 1 km^2 of potential fishing area. The estimated available area for lobster fishing is difficult to estimate for the Minas Passage area, because a portion of it is affected by high currents and nearer the Cape Split side, depths increase dramatically to 90 - 100 m. As noted earlier, it is difficult to assess the catch by areas within the broader LFA 35 and as a result it is difficult to determine a reduction in profitability of the lobster fisheries in the localized Project area. Secondly, the distribution of lobster traps is not consistent and trap locations change during the season to track lobster movement, and so it is difficult to define specific lobster trap locations year to year (Collins pers. comm. 2009). In addition, the traps are baited which acts as fish attractants for 100 m or more (Miller pers. comm. 2009). Given these factors, the fisheries/safety exclusion is not anticipated to have significant adverse effects on lobster catches. Therefore, the local commercial fisheries in general will see no major impact on overall lobster catches, but there may be an impact at the individual fisher level. Based on an analysis of current fishing activities near the Project area, it does not appear that the lobster fishers who routinely fish in the vicinity of the deployment area will be significantly displaced or experience measureable impact.

The potential interference of Project vessels with the lobster fishing vessels can be minimized through effective planning and communication. Measures to be taken include:

- Construction activities (*i.e.,* turbine deployment, cable laying, drilling of pile foundations, if required) will be undertaken during non-lobster fishing season to the extent possible;
- Maintenance activities will be scheduled, whenever possible, during non-lobster fishing seasons;
- Decommissioning of the site will be done during non-lobster seasons;
- If activities must take place during lobster season, the fishers will be informed of the vessel movements, timing and locations. If it determined necessary that traps be relocated and/or fishing vessel movement restricted, then a mutually acceptable plan will be developed to identify appropriate compensation for displacement from the area for a given period; and
- Project vessels will operate in specified routes to minimize interaction with non-project vessels.

Additional vessels will result in increased noise levels, but the construction activities will be of short duration and spread out for a couple of years, thereby likely having minimal effects on lobsters in the area.

The impact of the MCT surface piercing structure on the safety and navigation of local fishing vessels is considered minimal since this structure will be well marked on charts and on the sea in accordance with the requirements of Transport Canada's *NWPA* Permit conditions. Navigation is discussed in more detail in Section 3.4.8.

The GBS for the turbines will have small footprints on the seabed. The spatial dimensions will vary, but will be between 30 m x 30 m as described in Section 2.3.1. The pad footprints will result in the loss of fish habitat over very small areas, and HADD authorizations, and possibly Fish Destruction, approvals will be required. The loss of lobsters due to the deployment of the turbines is likely to be very limited, and the lobsters that are displaced are expected to return within a fairly short time period after the activity is completed. The GBSs may act as habitat for lobsters because these structures will provide refuge from high currents in the area.

The turbines will be between 350 to 500 m apart, depending on the final micrositing for each turbine, so the three turbines are not likely act as a physical barrier to lobster migration through the area. Similarly, the cables on the seabed are 125 mm in height and therefore would not act as a physical barrier to lobster movement. Previous studies in offshore oil and gas industry did not identify physical barriers (pipelines) to the movement of lobsters, nor did noise and EMF generally affect this activity (Martec Ltd *et al*. 2004). The impacts of noise from the turbines and EMF are addressed in more detail under the Marine Fish and Water Quality VEC Section 6.2. These effects will receive further study as part of the monitoring program and will be identified in the EMP.

If the MBP&P/MCT turbine uses a pile foundation, then drilling may result in a loss of fish habit in the immediate vicinity. The effect will be very limited in extent since each pin pile is only 1.5 m in diameter. As part of the drilling process, there will be noise generated and the release of a small amount cuttings which will be returned to the sea. Drilling may result in the displacement of lobster from the area, but is anticipated to be a short lived, localized activity and lobsters will return after it is completed as suggested in other studies (Payne *et al*. 2008, Martec Ltd. *et al.* 2004).

The laying of the three cables may result in lobster fisheries damaging or losing fishing gear due to being caught on the cables or the turbines. To minimize the potential for damage, cable coordinates will be provided so fishers can avoid placing their equipment in the area. If damage does occur it will be incumbent on the gear owner to demonstrate a loss of gear following international protocols (International Convention 1984), and FORCE will work with the gear owners to determine the appropriate level of compensation. A process will be established through discussions between the Fishers Contact Committee and FORCE. If the 300 m fisheries/safety zone around the turbines is respected, then there should be minimal issue related to the loss or damage of gear. In the situation where fishing gear such as lobster traps are dragged into turbines by debris and a turbine is damaged, the fisher will not be held liable. This issue will be addressed within the FORCE and Device Owners Agreement such that the Project insurance will cover such incidents.

The movement of vessels during the construction and maintenance activities carries a risk for accidental spills and this is addressed under Section 7.0, Accidents, Malfunctions and Unplanned Events.

6.9.5 Follow-up and Monitoring

FORCE and the device owners will implement a detailed monitoring program for the demonstration facility. The details of the program will be developed in consultation with the relevant federal and provincial regulatory agencies and incorporated into the Environmental Management Plan for the Project.

A Fishers Contact Committee has been established to ensure timely communication regarding Project activities that may impact local fishers and ongoing discussion of issues which may potentially impact fishers. In addition, FORCE and the device owners will work in cooperation with the local fishers via the Fishers Contact Committee to design and implement lobster catchability studies, as deemed necessary, to determine the before and after effects, as far as possible, on lobster fishing in the Project area and vicinity.

6.9.6 Summary of Residual Environmental Effects Assessment

Potential adverse effects on the commercial lobster fisheries will be eliminated or minimized to insignificant levels throughout the Project life. This will accomplished by working with the local lobster fishers to ensure ongoing and timely communication related to construction, maintenance, monitoring and decommissioning activities in order to minimize interference with lobster fishing seasons.

The issuance of Notices to Mariners and updated charts and coordinates for turbine and cable locations, and the use of a 300 m radius fisheries/safety exclusion area around the turbines will decrease the likelihood of interaction between vessels and fishing gear with the Project infrastructure. The proposed fisheries/safety exclusions zones will be small compared to the available fishing grounds within the Minas Passage/Channel area. However, it is recognized by FORCE that a baseline lobster catch program operated over several fishing seasons will likely be required to determine if there is an effect on lobster catches and profitability for individual fishers. Gear damage losses that can be demonstrated will be addressed through compensation on a case by case basis, following international protocols.

The effects of the Project on fish behaviour are addressed in Section 6.2 and will be assessed by an ongoing monitoring program to be included in an EMP for the Project. Accidents, malfunctions and unplanned events are accessed in Section 7.0 and cumulative effects are assessed in Section 8.0.

6.10 Archaeological and Heritage Resources

Archaeological and Heritage Resources were selected as a VEC since the general area is known for First Nation, Acadian and Loyalist settlement. As with any construction project, there is potential for damage to marine and or terrestrial archaeological sites, including First Nations/Aboriginal Sites, when projects are undertaken. Both regulatory agencies and the public have on-going concerns with the effective management of archaeological and heritage resources at most construction sites.

6.10.1 Boundaries

Spatial boundaries for the assessment of archaeological and heritage resources include all areas of the Project footprint, which is all areas of the terrestrial, intertidal and marine environments that the proposed onshore facility, cable corridor and marine Demonstration Facility will physically disrupt. The assessment of potential Project effects on archaeological and heritage resources is focused principally on those Project activities that will cause ground disturbance. Project related effects on archaeological and heritage resources are most likely to occur during the construction phase and environmental effects to such resources (if present) would be permanent and irreversible.

Temporal boundaries for archaeological and heritage resources consider that these resources are permanent rather than seasonal features of the environment. Given this, construction and decommissioning activities undertaken at any time of year have the potential to affect the integrity of any archaeological or heritage site encountered.

Archaeological and paleontological resources in the province of Nova Scotia are protected under the Nova Scotia *Special Places Protection Act* administered by the Nova Scotia Museum of Natural History. Sites considered as valued archaeological or paleontological resources may not be disturbed except under strictly controlled conditions imposed by the terms of a Heritage Research Permit. The Nova Scotia Museum is also responsible for approving or modifying recommended mitigation measures designed to protect any resources encountered.

Information regarding archaeological and heritage resources within the Project area was gathered from a variety of sources including archival research, examination of archaeological resources files at the Nova Scotia Museum, air photo interpretation, and an archaeological site survey by a qualified archaeologist on September 19 and 20, 2008 under Heritage Research Permit A2008NS72 (Appendix 10).

6.10.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on archaeological, paleontological and heritage resources is defined as any disturbance to, or destruction of, these resources considered by First Nation or Aboriginal communities or provincial heritage regulators to be of major importance due to factors such as rarity, undisturbed condition, spiritual or research importance, and that cannot be mitigated.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on archaeological and heritage resources is defined as one that results in enhanced understanding of local, regional or cultural heritage through increased knowledge, or provides physical protection for a site that might otherwise have been destroyed through natural or non-project man made events, in the absence of the Project.

6.10.3 Potential Issues, Interactions and Concerns

As noted above, the archeological study concluded the terrestrial Project area has a high potential for late eighteenth and nineteenth century archaeological resources remaining after Loyalist and later occupation of the area. The potential for encountering Mi'kmaq archaeological resources was also considered high on the shore of the Bay of Fundy, mainly due to the potential use of the beach as a stopping area. The desktop study also identified two vessels grounded on Black Rock although no specific wrecks were located within the Project footprint. The study noted that high currents would like destroy and/or transport any wreckage that may have been present (Davis Archaeological Consultants Limited 2008).

The potential for disruption or destruction of terrestrial archaeological and heritage resources is highest during (a) the initial construction phase of the land-based facilities (including the building, electrical vault, electrical transformer and parking area) and (b) the excavation of the cable trench across the beach and intertidal zone.

The initial construction phase of the land-based facilities and affiliated structures consists of clearing and grubbing vegetation and leveling sites in preparation for construction. The electrical vault, measuring 2.0 m x 2.0 m by 4.0 m deep would be excavated at the same time. This work is expected to be completed in late summer, 2009, and will require approximately one week to complete.

The cable trench will measure approximately 4.0 m wide and 1.0 m deep. Mechanized excavation equipment will occupy an additional zone approximately 6.0 m wide on each side of the trench during the trenching activities. Trenching is expected to occur sometime in August - October, 2010 and will be completed over a two day period.

6.10.4 Analysis, Mitigation and Residual Environmental Effects Prediction

No specific archaeological or heritage resources were identified in the areas slated for development and so no specific mitigation measures are proposed at this time. Nevertheless (as described below), should such resources be encountered, a variety of mitigation techniques including as outright avoidance of the resource (*i.e.,* displacement of the project feature), preservation in-situ, and archaeological excavation can be employed at the recommendation of the site archaeologist. Providing these standard mitigation measures are employed in a timely fashion, no residual environmental effects are anticipated.

6.10.5 Follow-up and Monitoring

The archaeological report recommends that, given the potential presence of First Nations artifacts in the Project area, a professional archeologist should be present to monitoring construction and excavation, including the cable trenching. This recommendation is supported by the Heritage Division of NSDTCH (letter, November 17, 2008) who go on to note "In the unlikely event that archaeological resources are encountered during ground disturbance activities, it is recommended at all disturbance cease and the Manager of Special Places be contacted."

The proponent will engage a professional archeologist to monitor the initial phase of construction of the interpretive centre and affiliated structures, as well as the cable trenching activities.

6.10.6 Summary of Residual Environmental Effects Assessment

As noted, no specific archaeological or heritage resources were identified in the areas slated for development. If found, standard archaeological mitigation measures will be employed to ensure these resources are preserved. No residual environmental effects are anticipated.

6.11 Tourism and Recreation

Tourism and Recreation is retained as a VEC since these activities are of evident value to the community of Parrsboro and were raised on numerous occasions during stakeholder consultation sessions. Tourism represents a significant economic activity in the region, which is known for camping, hiking, rock and mineral collecting, boating and sightseeing. There is a potential interaction with recreational boating during all phases of the project mitigation measures may be required to safely address this interaction. In addition, the project presents some potential for tourism gain to the area. Finally, both marine and land-based tourism and recreational activities in the area rely on the Bay of Fundy and the Minas Passage to attract visitors.

6.11.1 Boundaries

Determinations of the spatial and temporal boundaries of the Project have been developed considering potential interactions with tourism and recreation. Spatial boundaries for the evaluation are based primarily on the location of Project infrastructure. This area also includes zones of potential influence from the Project on recreation and tourism with regard to visual aesthetics, noise and dust emissions. The spatial boundary includes all areas of the Project footprint or all areas of the terrestrial, intertidal and marine environments that the onshore facility, cable corridor and deployment area will physically disrupt, as well as the Minas Channel and the Town of Parrsboro.

The temporal boundaries have been developed in consideration of the time period during which recreation and tourism will be affected. This will include the construction and decommissioning periods and through the operational life of the Project. Other temporal considerations with respect to recreation and tourism include those times of year and day when use and enjoyment of lands or waters for recreation or tourism activities may be more or less affected by aspects of the Project (*e.g.,* noise, visibility).

The assessment of the potential interactions between the Project and tourism and recreation relies on existing information and data. In addition, information was obtained through interviews with key stakeholders, site visits, secondary data and document reviews.

A description of the existing environment related to recreation and tourism in the area is provided in Section 3.4.4.

6.11.2 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on tourism and recreation is one where the proposed Project is not compatible with tourism and recreational activities in the area, and the Project will create a change or disruption that restricts or degrades present uses such that recreo-touristic activities cannot continue to be undertaken at current or recent levels and is not compensated, or results in a measurable reduction in tourism incomes or profitability.

An adverse effect that does not meet the above criteria is evaluated as **not significant**.

A **positive** effect on tourism and recreation occurs when the Project results in enhanced land and resource use for tourism and recreation, or results in a measurable increase in tourism incomes or profitability.

6.11.3 Potential Issues, Interactions and Concerns

The following issues and concerns were identified during a number of public interactions including public meetings, stakeholder discussions and direct communication with individuals, particularly in the Parrsboro and surrounding area:

- The potential to disrupt tourism, especially ecotourism (*i.e.*, sea kayaking) during construction due to additional vehicle and vessel traffic;
- Restricted access to a beach used by the local community for recreational purposes;
- Potential visual impacts associated with the above surface structure for MBP&P/MCT turbine; and
- Concerns related to the best location for the Project interpretive centre (*i.e.,* at the Project landfall site or in Parrsboro).

6.11.4 Analysis, Mitigation and Residual Environmental Effects Prediction

As part of the Project land-based facilities, an interpretive building is proposed in conjunction with a research facility. The building would have “green” construction features and provide views of the Project area. The site would include parking lot for buses and cars. The aesthetics of the Demonstration Project will not interfere with the overall aesthetics and visitor experience of the local area.

There are currently no marine operators of tour boats or kayaks based in the Parrsboro harbour (McCulloch, pers. comm. 2009). Several kayak companies (including NovaShores Adventure) primarily operate in the Cape Chignecto/Advocate Harbour area. The proposed Project marine area and land fall site do not interfere with kayaking operations and do not affect access or use to any public beaches (NovaShores Adventures pers. comm. 2009). Therefore, there will likely be no direct or indirect negative impacts on this type of activity. It was suggested that a proposed interpretive building at the Project landfall site would likely have a positive impact on the quality of the visitor experience at local tourism businesses and attractions, as noted by local tourism operators (NovaShores Adventures pers. comm. 2008, Gillespie House Inn B&B pers. comm. 2008) and as identified at several stakeholders meetings and the Open House and Feedback Session in Parrsboro. Local bird watching activities will also not be negatively impacted as a result of the proposed Demonstration Facility.

The concept of an above sea surface structure was discussed at several stakeholder meetings, public presentations and at the Open House and Feedback Session (see list of meetings in Table 5-3, Section 5.2). There were no negative reactions or concerns raised related to this type of structure by the public during these presentations. It was suggested that a visible structure would be additional attraction for the area by providing a visible location for the Project’s submarine location from the interpretive building.

From a perspective the local community of Parrsboro and the surrounding area, the ultimate location of the interpretive building was a subject for further discussion, whether in Parrsboro or at the Project landfall site off West Bay Road. Overall, it was viewed as a positive addition for the area regardless of its location and an opportunity to link to other attractions such as the Fundy Geological Museum (Adams pers. comm. 2008) and for the future development of new tourism products.

6.11.5 Follow-up and Monitoring

No follow-up monitoring is recommended. Ongoing communication with the community will be maintained throughout the Project life, through a Public Liaison Committee.

6.11.6 Summary of Residual Environmental Effects Assessment

It is anticipated that there will be a **positive** impact on tourism and recreation in the Parrsboro and surrounding area, because of the interpretive building at the Project landfall site and the opportunities for linkages to other tourism attraction in the area.

7. Accidents, Malfunctions, and Unplanned Events

Potential accidents, malfunctions and unplanned events associated with the Project include small terrestrial or marine spills of hazardous materials (fuels, lubricants), large marine spills of hazardous materials, vessel accidents/collisions, failure of erosion and sedimentation control measures during construction, discovery of archaeological, heritage or First Nations/Aboriginal resources, and fires. It is difficult to predict the exact nature of events and their severity should they occur, however, the probability of serious accidental events causing significant adverse environmental effects is low since both construction and operational procedures will be designed to incorporate contingency and emergency response planning.

All necessary precautions will be taken by the proponent to ensure prevent the occurrence of accidents, malfunctions and unplanned events that may occur during the life of the Project, as well as minimizing any environmental effects of such events. Construction and operational activities will be conducted in accordance with all relevant regulations, guidelines and industry Best Management Practices (BMPs).

The objective of assessing possible accidents, malfunctions and unplanned events is to ensure that:

- Potential accidents, malfunctions and unplanned events are identified so that response can be planned;
- Abnormal events or conditions which could upset Project operations are considered; and
- The significance of the residual effects from accidental events is determined (after mitigative measures are implemented).

This assessment will not address all conceivable accidents, malfunctions or unplanned events, but only those that are perceived to have a reasonable probability of occurring, and which may have an effect on the socio-economic or natural environment considering the design of the Project and the site specific conditions. Accidents malfunctions and unplanned events may also be instigated by external factors (natural or man-made). This assessment considered the likelihood of such instigating events as well as the resulting effects of such events.

The objective of this assessment is to determine if any accident, malfunction or unplanned event could be expected to result in a residual effect to the natural or socio-economic environment, considering the Project-specific features that would in themselves prevent or control such an incidence, as well as to mitigate possible effects of such an event.

All of the identified accidents, malfunctions or unplanned events are likely to be temporary in nature and limited in duration. Considering the Project specific mitigative measures contained throughout this document, accidents, malfunctions and unplanned events are expected to be rare, and the consequences temporary and subject to immediate clean-up and remedial measures, if required.

7.1 Spills

7.1.1 Terrestrial Spills

During construction of the on-shore facility, spills of petroleum, oils or lubricants could occur while refuelling equipment. Such spills would be limited to relatively small quantities, and would be highly localized and easily cleaned up by Project crews using standard equipment. In the very unlikely event of a large spill, soils, surface and groundwater contamination could occur. In this case, the event could adversely affect fish and fish habitat, wetland habitat, wildlife by ingestion or uptake, and depending on the nature of the spill, archaeological or heritage resources, or residential and other land uses. Prevention of spills is the most important step in averting these potential effects. The Project-specific Environmental Management Plan (EMP) will contain industry Best Management Practices to minimize the likelihood of a spill, as well as procedures for training and orientation of employees and contractors.

All petroleum, oils or lubricants as well as any other hazardous materials will be stored and handled in accordance with relevant regulations and procedures contained in the EMP, and the use of non-toxic lubricants (such as vegetable based oils) will be considered whenever possible. Proper equipment selection, regular inspections and maintenance programs will ensure the reliability and integrity of Project equipment. Refuelling of mobile equipment will take place in a designated area on a low permeability surface. No refuelling of mobile equipment will take place within 100 m of any watercourse, wetland and the intertidal zone. Equipment operators will ensure that they remain with all equipment at all times during refuelling in accordance with the NS*EA* Petroleum Management Regulations.

In the event of a minor spill or leak during refuelling or general equipment operation, actions will immediately be taken to stop and contain the spilled material. Spill containment and cleanup materials (absorbent pads and dry chemicals) will be available for trained personnel to handle small spills. All material that has been contaminated as a result of the spill or leak will be collected and stored in a manner which ensures that it will not be re-released into the environment until it is transported to an approved treatment or disposal facility. In accordance with the NS*EA*, Emergency Spill Regulations, all spills will be reported to the 24-hour environmental emergencies reporting hotline. The Project-specific EMP will also contain a Spill Contingency Plan, which will include contingencies for spills, including the type and use of cleanup equipment, training of personnel and identification of personnel to direct cleanup efforts, lines of communications and organizations that could assist cleanup operations. In the case of a minor spill, based on the nature and quantity of materials available and mitigation and contingency planning, the majority of adverse environmental effects due to unplanned spills are not considered significant.

In the unlikely event of a large spill of petroleum, oils or lubricants, local and provincial emergency response procedures will be invoked to minimize impacts. The environmental effects of an accident, malfunction or unplanned spill on soils, surface and groundwater, fish and fish habitat, wetlands and wildlife are considered significant, but very unlikely.

7.1.2 Marine Spills

Small spills/leaks are most likely to occur at valves and hose connections. If large quantities of hazardous materials were to be spilled into the aquatic environment, there is potential for significant adverse effects on marine biota, marine mammals, marine birds and aquatic habitat. Any spills in to the marine environment will likely be small in quantity and frequency and will disperse rapidly.

Adherence to BMPs and proper equipment selection, inspection and maintenance will act to prevent potential accidental spills. Monitoring, maintenance, and decommissioning, storage areas containing chemicals (including drilling muds, if required) and petroleum products will have secondary containment to prevent discharges onto decks and into the marine environment. Emergency response and contingency plans for accidents scenarios will be in place by the vessel contractors to ensure containment of any potential spills. Spill response planning will reduce the likelihood of contamination of the aquatic environment. Spill containment and cleanup materials (absorbent pads and dry chemicals) will be available for trained personnel to handle small spills. The emergency response plan will provide details regarding procedures for responding to larger or more serious spills, including contacts for first responders and cleanup crews. The appropriate regulatory authorities (*e.g.,* Coast Guard, Nova Scotia Environment) will be notified of all spills in reportable quantities in accordance with the NS*EA* Emergency Spill Regulations.

All shipping and offshore activities will be conducted in compliance with the *Canada Shipping Act* requirements for vessel inspection and certification, and training and appropriate certificates of competency for operators. Vessels and operators will be required to have procedures in place to safeguard against marine pollution including, but not limited to awareness training of all employees, means of retention of waste oil on board and discharge to shore based reception facilities, and capacity of responding to and clean-up of accidental spills caused by vessels involved in the Project.

The vessel contractor(s) selected for the Project will be required to provide a Project-specific spill contingency plan. The plan must be developed in consideration of the procedures provided by the Canadian Wildlife Service (CWS) in the draft document "Potential Components of a Spill Response Plan for Marine Birds" dated October 2007. Components of the response plan may include, but will not necessarily be limited to:

- Measures to prevent birds from coming into contact with spilled oil such as hazing or release of scare devices;
- Measures to prevent birds from contacting oil by getting oil off the surface of the water as soon as possible through dispersion of spilled material, using chemical or mechanical dispersants or natural dispersal by environmental conditions;
- Implementation of a humane response (*i.e.,* rehabilitation or euthanization) to oiled birds as required by Environment Canada's National Policy On Oiled Birds And Oiled Species At Risk through bird collection (ship-based effort) of live and dead birds both within the spill area and adjacent to it;
- Determination of the potential impact of the spill by monitoring wildlife by ship, structured aerial surveys, and placement of CWS staff on vessels and aircraft; and
- Beached bird surveys to determine the potential impact of the spill and identify any live wildlife in distress in order to implement a humane response (*i.e.,* euthanization or rehabilitation).

Effects of localized, minor spills on the aquatic environment would be minimal, as any such spills would be rapidly cleaned up in accordance with emergency response and contingency plans. A major spill is unlikely given the limited amounts of hazardous materials that would be available at any given time; however should the unlikely occur, emergency response would be rapidly due to emergency response planning. If such an event occurs, procedures will be put in place to respond to and investigate the occurrence and put in place any corrective actions deemed appropriate. Significant effects on the environment from spills of hazardous materials are considered unlikely.

7.2 Vessel Accidents/Collisions

Although the location of the Demonstration Facility was selected in consultation with other users of the Minas Passage to minimize the potential for Project related collisions with other vessels, there is a potential for collisions between vessels or between a vessel and surface piercing structures (or drill rig, if required). Additionally, there is potential for collisions of Project vessels or infrastructure with submerged or surface debris.

The risk of collision between vessels or between a vessel and surface piercing structure is expected to be extremely low based on compliance with standard procedures. An exclusion zone will be established and surface facilities will contain navigational aids and anti-collision radar to provide early warning of a potential collision hazard. A Notice to Mariners will be issued and appropriate mariner charts will be updated through the Canadian Hydrographic Service for the drilling period. In the unlikely event that a collision cannot be avoided, the Project-specific EMP will contain detailed response procedures.

The management of all vessels during Project activities in the Minas Channel area will be under the jurisdiction of the Canadian Coast Guard's Fundy MCTS based in Saint John, New Brunswick. All large vessel traffic movement in the Bay of Fundy must report to the Fundy MCTS at specified points in the Bay. Collisions will be mitigated through controlling vessel speed, scheduling and coordinating activities with other Passage users, Transport Canada and the Canadian Coast Guard (Fundy MCTS), and posting Notices to Mariners, which would result in permanent markings being established on the appropriate marine navigation charts. When vessel radio operators are present they will notify approaching vessels of their presence and the presence of structures. Berthing accidents would be expected to be infrequent and minor. Should deleterious substances be spilled though any such accident, emergency response and contingency plans for will be in place by the vessel contractors to ensure containment of any potential spills (see Marine Spills above).

Standard operating procedures would be developed to reduce the risk of collisions between ships and the drilling rig (if drilling is determined to be required) and may include the use safety zones indicated on nautical charts, issuance of a Notice to Mariners, and notification to approaching vessels by radio operators. The distance at which a mariner would receive notification would depend on the direction and speed of the approaching vessel and the existing weather conditions.

Most of the Minas Channel is between 25 m and 40 m in depth, extending to 100 m in the central trough. The speed of the tidal currents at all depths in the narrow part of the Channel reaches 6 to 8 knots. Water to the south of the main Channel is carried back and forth by tidal action but appears to remain essentially stationary over a complete tidal cycle. This is an area in which seaweed, driftwood and other debris collect and drift back and forth with the tidal ebb and flow from near Cape Split at the inner end to a point south of Isle au Haute at the outer. Fishermen state that this debris remains in the region until it becomes water-logged and sinks (Bousfield and Leim 1958). The potential for submerged or surface debris to interact with the Project is considered very unlikely as the area in which this activity takes places (and the debris remains) is located considerably to the south of the Project area. Sea bottom video, still photography and multibeam data to date have not revealed the presence of submerged debris in the deployment area. Over the longer term, detailed hydrodynamic modeling of currents in the Minas Passage may provide additional information regarding the risk of submerged debris in the Project area.

7.3 Erosion and Sedimentation Control Failure

A potential exists for failure of erosion and sediment control structures due to extreme precipitation events. Such a failure could result in the release of silt-laden runoff to receiving watercourses with adverse effects on surface water, wetlands, fish and fish habitat. Erosion and sediment control measures will be implemented according to industry best practices, standard requirements from the Nova Scotia Department of Environment and practices indicated in the Erosion and Sedimentation Control Handbook for Construction Sites. Plans for erosion and sediment control measures, as well as reponse procedures in the event of a control failure will be developed prior to the commencement of construction activities as a part of the Project-specific EMP, and will be implemented to minimize impacts to water quality from construction activities. These measures could include:

- Scheduling site activities to minimize disturbance;
- Avoiding leaving excavations open for long periods and compaction/covering loose materials;

- Compacting soils as soon as excavations, filling or levelling activities are complete;
- Installation of silt fences, hay bales, etc. to minimize the transport of silts;
- Implementing measures to control sedimentation and erosion and ensuring that construction personnel are familiar with these practices and conduct them in the appropriate manner;
- Controlling runoff during the construction phase; and
- Monitoring any runoff to ensure total suspended solids levels are within acceptable ranges.

In the unlikely event that runoff exceeds acceptable ranges for total suspended soils as determined through monitoring, contingency measures may include pumping of sediment laden water to vegetated areas (away from down gradient water systems) or through filter bags for additional filtration and/or the implementation of additional sedimentation ponds or erosion and sedimentation control structures. Remedial action will be rapidly taken as necessary. In the event of a failure, Project construction will be shut down until controls are restored. An erosion and sediment control failure leading to a significant adverse effect on any VEC is considered unlikely.

7.4 Archaeological and Heritage Resource Discovery

As discussed in Section 3.4.7.1, there is a potential for discovery of archaeological and heritage resources during construction of the on-shore facility. The effect of accidents, malfunction and unplanned events could be significant if any archaeological or heritage resources were affected by unplanned soil removal during the construction phase of the Project, particularly soil removal in any areas of high archaeological potential.

Wherever possible, efforts will be taken to avoid disturbance to the ravine and cellar sites. Given the potential for First Nations artifacts at the Project site, an archaeologist will be present to monitor all geotechnical testing and the excavation of the trench from the beach to the building site. In the unlikely event that archaeological resources are encountered during ground disturbance activities, contingency measures will be in place, including ceasing work and contacting the Nova Scotia Museum immediately upon discovery. Work in the area will continue in consultation with the museum.

It is anticipated that adhering to these contingency procedures would mitigate impacts related to the unplanned discovery of any archaeological or heritage resources during Project activities.

7.5 Fires

Fires may result in wildlife disturbance, habitat loss, direct mortality to wildlife, loss or damage of property, and loss or damage to archaeological and heritage resources. As with all accidents, malfunctions and unplanned events, the most important step in preventing effects of forest fires is to prevent fires from occurring. Material management and operational procedures will reduce the frequency and extent of accidental fires related to the Project. Burning of vegetation and debris will not be permitted.

In the unlikely event of a fire, local emergency response and fire fighting resources will be able to reduce the severity and extent of damage. A fire prevention procedure will be included in the Project-specific EMP to reduce the potential for fires. The EMP will also include procedures for employee and contractor training and orientation information, as well as fire response and emergency notification procedures.

Although the possibility of a large fire is low, the environmental effects of an accidental forest fire on wildlife and wildlife habitat could be significant. In consideration of the mitigation and contingency plans, significant adverse effects are not likely. Habitats would begin to recover from a forest fire after a single generation and continue through the natural phases of succession; however, return to the natural state pre-fire may take multiple generations.

In summary, effects of accidents are not considered to be significant in most cases due to the development and implementation of emergency response and contingency plans contained within the EMP designed to limit interactions with the natural or socio-economic environment. The proponent will have requirements in contractor agreements which stipulate that the contactor is required to have emergency contact numbers on hand and procedures available for accidents, malfunctions or unplanned events that may occur after hours. Significant adverse effects are considered unlikely to occur.

8. Cumulative Effects Assessment

Environmental and socio-economic interactions of individual projects have the potential to overlap spatially and temporally to create a cumulative interaction. In some cases cumulative effects may interact in an additive fashion, creating an effect equal to the sum of the individual project effect. In other cases cumulative effects may interact synergistically, creating an effect greater than those of the individual projects. According to the Fundy Tidal Background Report (Jacques Whitford *et al.* 2008), cumulative effects are especially evident in aquatic environments, where project developments could potentially create off-site impacts that can be propagated over considerable distances. Cumulative effects may have important regional consequences in the context of large project development, or in the context of smaller projects, result in local, incremental changes. This assessment considers potential cumulative environmental and socio-economic effects for each project VEC, as required by the *CEAA*. Specifically, the assessment will determine the extent to which the individual project will contribute to the total cumulative effects of developments and human activities within the region.

As per subsection 16(1)(a) of *CEAA*, every project undergoing a screening is required to include an assessment of the "cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out". Generally, the evaluation of cumulative effects can be considered as a sequence of steps including:

- Identification of environmental and socio-economic effects of the Project;
- Identification of other projects/activities that could interact with Project related effects;
- Elimination of the effects of other projects/activities that are unlikely to act in combination with Project related effects;
- Identification of likely effects that could result from the interaction of Project related effects with other projects/ activities; and
- Evaluation of the significance of likely cumulative environmental and socio-economic effects.

The consideration of potential future projects/activities for cumulative effects assessment will be limited only to those projects/activities that have a reasonable likelihood of proceeding, and will not include speculative project/activities, such as the removal of a large part of the Windsor Causeway in Nova Scotia, an example cited in the Background Report (Jacques Whitford *et al.* 2008). Projects/activities considered as having a reasonable certainty of proceeding will have (at least) submitted applications for regulatory approval or have undertaken some advanced planning. In some cases, it may be helpful to consider clarification made by the Joint Review Panel on an Alberta pipeline project, which determined that certain requirements must be met before cumulative effects will be considered. These requirements include that there must be a measurable environmental effect of the project being proposed, the environmental effect must be demonstrated to interact cumulatively with effects from other projects/activities, it must be known and not hypothetical that the other projects/activities have been, or will be carried out, and that the cumulative effect is likely to occur (*i.e.,* there must be some probability and not just possibility) (NEB and CEA Agency 1996). The significance of cumulative effects will be evaluated in accordance with the significance determinations developed for each VEC.

Cumulative interactions with past and present project activities have generally been included in the discussions of the existing environment in the Project area (Section 3.0). Some future approved projects are relatively well defined, while other likely activities are more difficult to define in terms of potential spatial and temporal interactions with the Project. Current and ongoing vessel traffic related to shipping, commercial and recreational fishing, and tourism may interact cumulatively with Project related activities (*e.g.,* effects of exclusion zones, increased demand for onshore and offshore infrastructure and facilities, increased vessel traffic and underwater noise), however, as there are no anticipated changes to current activities (*i.e.,* increases), Project related interactions with these VECs have been assessed in the Environmental Effects Assessment, Section 6.0 of this document. The potential for adverse effects associated with the Project will be reduced by the proper implementation of mitigative measures contained throughout this environmental assessment and through adherence to applicable legislation, guidelines and Best Management Practices. Additionally, in a submission in February of 2008, DFO indicated that “it is assumed that impacts of test installations will be localized and far field impacts will likely remain undetectable” (DFO submission, February 29, 2008).

No future development projects, or changes to current activities have been identified which are expected to overlap spatially and temporally with the Project. Review of the provincial and federal Environmental Assessment registries does not reveal any newly proposed future projects that will overlap temporally or spatially with the Project. As a result, cumulative interactions are not likely to result in any significant adverse environmental effects. Mitigation and monitoring related to other projects/activities is outside of the proponent’s control or responsibility, however, due to the objectives of the Demonstration Facility, there exists an opportunity for the proponent to participate in regional monitoring and planning efforts in order to help manage regional effects, including cumulative effects. As the near and far-field effects of marine renewable energy are currently not well understood, the OEER recommended that the Province of Nova Scotia establish a Marine Renewable Energy Demonstration Program in part to initiate longer term research needed to predict cumulative and far-field effects in commercialization (OEER 2008). The Background Report concludes that in order to avoid negative affects from a number of small individual projects, a Bay-wide planning concept is needed (Jacques Whitford *et al.* 2008).

9. Effects of the Environment on the Project

The definition of an environmental effect includes any change to the project that may be caused by the environment. For this project, potential effects of the environment are limited to extreme weather events (*e.g.,* heavy precipitation and storm surge); climate change (*i.e.,* sea level rise); sea ice; and seismic hazards.

9.1 Extreme Weather Events

Extreme weather events have the potential to cause schedule delays and potential environmental damage associated with erosion and sediment control during the construction and decommissioning phases when there is disturbed ground. Mitigation measures include, but are not limited to, scheduling activities in consideration of weather conditions and to accommodate weather interruptions. Furthermore, equipment to be utilized for this project is designed to operate outdoors in most weather conditions.

There are several sources of information that the proponent and contractors will use to monitor for potential extreme weather events including advisory and warning bulletins which are issued by Environment Canada when there is a potential or likelihood of coastal flooding. These bulletins typically include a meteorological description of the event, information on the coastlines that are most likely to be affected, a discussion of complicating factors such as ocean waves and pack ice, as well as an assessment of the severity of the event.

Given the limited extent of the footprint, duration for construction, and lifespan of the Project (*i.e.,* one to four years depending on the time of device deployment and demonstration period), extreme weather events are not considered to result in a significant adverse environmental effect.

9.2 Climate Change

Global warming is occurring and is believed to be the result of increasing concentrations of greenhouse gases in the atmosphere (IPCC 1990; IPCC 1995). This warming effect is anticipated to contribute to an increase in ocean volume largely from the melting of polar ice (*i.e.,* sea level rise). In addition to sea level rise, other atmospheric changes associated with climate change may include increased storm frequency and intensity as well as changes in surface winds, ocean waves, storm surges and ice conditions (Forbes *et al*. 1997).

A report was prepared (Appendix 3: Fader 2009), which provides an assessment of the hazard posed by global sea level rise associated with the proposed Project area. An understanding of the future projected change in sea level that includes effects of global warming is important for the design of Project infrastructure. The infrastructure for the Project includes buildings, cables, gravity based structures and a sea level surface piercing structure. Project components will be designed using the most up to date information on sea level rise and will consider the life expectancy of the Project.

The glacial, post glacial and historical sea level knowledge has implications for the construction of offshore infrastructure as well as on land components. Of greatest importance to the design of structures that may pierce the sea surface is consideration of the continued projected rise in sea level. Based on the knowledge of sea level change over the past 50 years, new facilities should be designed and constructed to anticipate a sea level rise of 30 cm per century for natural crustal changes combined with a further 18 to 100 cm associated with global climate change by 2100. Design must also take into consideration potential change in tidal heights and storm waves associated with higher sea levels. Given the limited lifespan of the Project, sea level rise is not expected to have a significant adverse environmental effect on the Project.

The above information will also be considered in the design and construction of the land based facilities. It should be noted that the proposed location of the Project land based facilities, including the vault are greater than 5 m above sea level, with a minimum setback of 90 m from the beach ridge.

Associated with climate change is the potential for increased active weather, including a higher frequency of storms, resulting in concerns such as storm surges. The Minas Channel has a low wave potential as described earlier in Section 3.2.1; however, this will be a design consideration for the surface piercing structure.

9.3 Sea Ice

The potential impacts of ice, both surface and submerged, on the Project are discussed in Section 3.2.3, including a description of present and future monitoring of ice in the Project and Minas Passage areas. Multiyear studies are currently being undertaken by Oceans Ltd. in support of this Project. In support of the program, a request is being made that CIS start to collect surface ice data on a regular basis. There are two separate potential hazards which can arise from ice in this area and one of the tasks facing the device developers is to understand and qualify the degree of risk. The first issue is that of ice cover. Any marine operations, installation, service or removal, which must take place during the ice season will face the potential of being carried out in the presence of sea ice and permanent installations may accumulate ice in the winter. The second issue is that of neutrally or negatively buoyant ice floes, formed on the intertidal zone with embedded sand, gravel and rocks that may drift with the tidal current and pose a physical risk to the actual turbines.

Turbines entirely existing below the sea surface (Clean Current and OpenHydro) have been designed in consideration of ice effects. Based on the present scenario for the MCT generator, there will be a visible portion of the turbine’s support structure projecting above the sea surface. The surface structure will be relatively small (approximately 15 m x 15 m x 4 m) and will extend approximately 21.5 m above sea level at low tide. The MCT turbine will be designed withstand the effects of surface ice accumulation and impact on the surface piercing structure. All Project-related vessels will have equipment and procedures in place to adequately address ice conditions. The EMP will also include procedures for ice management, as required.

9.4 Seismic Hazards

A report was prepared to provide an assessment of the potential seismic hazards for the proposed Project area, as well as the regional and local distribution of faults and earthquakes (Appendix 3: Fader 2009). The continual movement of large segments of the earth's crust, called tectonic plates, is the cause of more than 97% of the world's earthquakes. Eastern Canada is located in a stable continental region within the North American Plate and has a relatively low rate of earthquake activity. Nevertheless, large and damaging earthquakes have occurred there in the past and may occur in the future.

The causes of earthquakes in eastern Canada are not well understood. Unlike plate boundary regions where the rate and size of seismic activity is directly correlated with plate interaction, eastern Canada is part of the stable interior of the North American Plate. Seismic activity in areas like these tends to be related to the regional stress fields, with the earthquakes concentrated in regions of crustal weakness. Although earthquakes can and do occur throughout most of eastern Canada, years of instrumental recordings have identified certain clusters of earthquake activity. In these clusters, earthquakes occur at depths varying from surface to 30 km deep.

The Minas Passage is located within the Northern Appalachian Seismic Zone (NAN). Maps of seismic risk show the area occurs within an area that is considered to have a low earthquake risk. The most widespread and significant fault or fault zone in the Bay of Fundy region is the Chedabucto-Cobequid fault system. It is part of a much larger transform fault system that extends from the Grand Manan area of the outer Bay of Fundy, north of Minas Basin, across Nova Scotia, through Chedabucto Bay to the Laurentian Channel. The name "Glooscap Fault System" has been proposed for this system that also includes the marine sector (King and MacLean 1976). Historically, earthquakes in the Minas Passage region have been infrequent and of small magnitude. The nearest zone of earthquake activity is likely associated with the Chedabucto-Cobequid Fault System and consists of two small earthquakes to the west and east. These did not occur within the proposed tidal power demonstration area.

Within Minas Passage the most evident fault is the Portapique Fault. It lies to the south of the volcanic platform that projects to the west from Black Rock and extends from an area off Cape Sharp in the east, to an area to the northwest of Cape Split for a distance of over 13 km. Although the Portapique Fault is a prominent fault on the multibeam bathymetry, there is no evidence for seismic activity on this fault.

Based on the above assessment and the limited extent and duration of the Project, the potential effects of the seismic hazards on the Project are considered to be unlikely and not significant.

9.5 Summary

Project components will be designed incorporating the most appropriate environmental design criteria to ensure the safety and integrity. The Project will be designed and constructed with the most recent meteorological, climatological, oceanographic and geotechnical data available to the designers and will include an appropriate factor of safety. Given the nature of the Project and its limited lifespan, sea level rise is not expected to have a significant adverse environmental effect on the Project. Monitoring and/or contingency planning will also serve to minimize any adverse effects. Effects of the environment on the Project are therefore predicted to be not significant.

In summary, seismic hazards, climate change and extreme weather are not anticipated to significantly affect the proposed Project provided that infrastructure is designed using the most up to date information to address predicted sea level rise in the region.

10. Summary and Conclusions

10.1 Summary

FORCE proposes to construct, operate and decommission a Tidal Energy Demonstration Facility in the Minas Passage, near Parrsboro, Nova Scotia. The facility will consist of three subsea turbine generators of differing technologies, subsea cables connecting the turbines to a land-based infrastructure, an onshore transformer substation and buried power lines connecting to the local power distribution system.

The main objectives of the Demonstration Facility are:

- To build, own and operate a tidal energy Demonstration Facility in Nova Scotia to test and demonstrate in-stream tidal energy devices designed to convert tidal kinetic energy to electrical energy; and
- To acquire information and knowledge necessary to assess the performance of tidal energy devices including their effect on the environment and the effect of the environment on the devices.

The Project is anticipated to begin in the fall of 2009, pending acquisition of all required regulatory authorizations. The following schedule is currently proposed:

Table 10-1 Proposed Project Schedule

Date	Activity
Sept./Nov. 2009	Deployment of the NSPI/OpenHydro Turbine
Aug./Sept. 2009	Begin construction of the onshore electrical facility
Mar. 2010	Connection of electrical facility to the NSPI power line
Aug.- Oct. 2010	Installation of subsea cables
Aug.-Sept. 2010/2011	Turbines deployed and connected to cables

The demonstration turbines will operate for a period of at least one year, which can be extended up to a maximum of four years. The detailed description of Projects components and activities is included as Section 2.0 of this report.

The Project requires federal and provincial environmental approvals including federal and provincial environmental assessments (EA). This report provides the basis for an Environmental Screening under the *Canadian Environmental Assessment Act* (CEAA) and satisfies the requirements for a Class I Registration under the Environmental Assessment Regulations of the Nova Scotia *Environment Act*. This EA Report describes and evaluates the potential environmental and socio-economic effects of the Project during all Project phases.

Early in the Project development stage, a scoping process was undertaken to identify Valued Environmental Components (VECs) most appropriate for this assessment. Study scoping included regulator and stakeholder consultation, regulatory issues and guidelines, research, and professional judgment of the Study Team. The following VECs were selected for the assessment:

- Marine Benthos
- Marine Fish and Water Quality
- Marine Mammals
- Marine Birds

- Marine Species at Risk
- Intertidal Environment
- Terrestrial Wildlife and Wildlife Habitat
- Terrestrial Species at Risk
- Recreational and Commercial Fishing
- Archaeological and Heritage Resources
- Tourism and Recreation

Each of the VECs selected for the assessment was evaluated for potential interactions between the VEC and Project activities during all project phases (*i.e.,* construction, operation and decommissioning) as well as malfunctions or accidents that may occur. These interactions were evaluated for potential significance after application of technically and economically feasible mitigative measures, where appropriate, to reduce or eliminate potential Project-related adverse environmental effects. The cumulative effects of the proposed Demonstration Facility in conjunction with past, present and likely future projects were also evaluated. Environmental monitoring and follow-up measures are proposed and will be undertaken to ensure compliance with applicable regulations, standards and guidelines, to verify environmental effect predictions and refine mitigative measures where required, as well as to gather important information to further evaluate the potential for environmental effects for future larger scale tidal energy projects (*i.e.,* commercialization).

The Project will be constructed, operated and decommissioned in accordance with applicable legislation, permit conditions and accepted industry best practices. The Proponent, the device owners and the contractors will be proactive in planning and implementing procedures to prevent pollution, will continually improve environmental performance and will manage environmental issues as a priority.

Some of these measures are inherent in the Project design and represent standard practices for subsea infrastructure, such as the use of biodegradable lubricants and non-toxic antifouling coatings. While these measures may not be specifically related to a particular VEC, they are nonetheless important in demonstrating the commitment to identifying and managing potentially adverse environmental effects. Additional environmental design and construction features include, but are not limited to:

- Design of turbine devices to minimize noise emissions and potential for injury from collisions;
- Use of gravity based structures for ease of installation and removal with minimal disturbance to bottom sediments/habitat;
- Trenching in the intertidal zone for cable installation at low tide to minimize sedimentation in the nearshore and marine environment;
- Scheduling of activities to the extent practical to avoid sensitive periods for various wildlife species;
- Development and implementation of an Environmental Management Plan including specific environmental protection procedures and monitoring programs.

In addition to the environmental design and construction features described above and in Section 2.0, the VEC assessment has confirmed the need for further VEC-specific mitigation. This mitigation must be economically and technically feasible to manage potential adverse environmental effects of the Project and promote sustainability. These are summarized by VEC in Table 10.2 below and will also become part of the Project EMP.

Table 10-2 Summary of Mitigation, Follow-Up and Monitoring by VEC

VEC	Proposed Mitigation	Follow-up and Monitoring
Marine Benthos	• Use biodegradable lubricants. • Obtain HADD Authorization, if required, for loss of fish habitat and complete compensation as required/negotiated.	• Monitor changes to benthos at the turbine sites through follow up video surveys • Develop and undertake noise monitoring for each turbine as well as for potential cumulative effects of all three turbines together.
Marine Fish and Water Quality	• Use of anti-fouling paints so as to minimize reef effect which can attract fish. • Limit use of artificial lighting to only what is required for safe operations. • Use biodegradable lubricants.	• Develop and undertake noise monitoring for each turbine as well as for potential cumulative effects of all three turbines together.
Marine Mammals	• As much as possible, marine vessels will travel at slow constant speeds while in transit to minimize potential for collisions with mammals. • Use of anti-fouling paints so as to minimize reef effect which can attract fish (food supply for mammals).	• Develop and undertake noise monitoring for each turbine as well as for potential cumulative effects of all three turbines together. • Collect additional information related to the presence of marine mammals in the Project area in conjunction with other monitoring and vessel activities.
Marine Birds	• Reduce potential for collision by maintaining low and constant speeds. • Limit use of artificial lighting to only what is required for safe operations.	• Collect additional information related to the presence of marine mammals in the Project area in conjunction with other monitoring and vessel activities. • Monitor vessel decks and water for evidence of bird collisions.
Marine Species at Risk	• Maintain constant course and vessel speed under 14 knots. • Do not approach whales nearer than 100 m, nor by greater than 2 vessels at one time. • Use of anti-fouling paints so as to minimize reef effect which can attract marine species at risk.	• Develop and implement a monitoring plan to gather information related to noise levels associated with project. • Develop and implement a monitoring plan to collect information related to the presence of marine species at risk in the project area.
Intertidal Environment	• Obtain and comply with all required permits and authorizations. • Avoid construction activity during sensitive period for birds. • Limit equipment travel and repair any damage caused by equipment travel. • Place cable on stilts during cable pull to minimize disruption of habitat. • Install free spanning temporary bridge across small stream. • Trench, install cables, and backfill at low tide in one day.	• Conduct spring and summer 2009 wildlife and vegetation surveys and, if required, develop additional mitigative measures in consultation with regulatory agencies. • Monitor success/effectiveness of wetland compensation project, if required.

VEC	Proposed Mitigation	Follow-up and Monitoring
	• Use dam and pump to cross small stream under dry conditions. • Conduct fish rescue as required. • Restore to pre-construction conditions to the extent possible. • Install appropriate erosion and sediment control measures for on-land construction.	
Terrestrial Wildlife and Wildlife Habitat	• Minimize footprint/area of disturbance. • Allow regrowth of low growing species. • Preserve and reuse topsoil. • Undertake clearing activities outside breeding season for most birds (*i.e.,* April 1 to Aug. 15) to the extent possible. Otherwise conduct pre-clearing survey for nesting birds and establish a vegetatedbuffer zone around active nests until young have naturally fledged. • Limit use of artificial lighting to only what is required for safe operations. • Use only mechanical vegetation control (*i.e.,* no herbicides).	• Conduct spring and summer 2009 wildlife and vegetation surveys and, if required, develop additional mitigative measures in consultation with regulatory agencies.
Terrestrial Species at Risk	• Avoid construction activities in the salt marsh during spring and summer months where possible since soils and vegetation are exposed and more susceptible to disturbance • Avoid terrestrial excavation during heavy precipitation to prevent sediment transport. • Implement and maintain structures for erosion and sediment control and stabilize erodible soil as soon as possible. • Minimize corridor width where feasible to mitigate habitat fragmentation. • Replace topsoil to retain native seedbank. • Allow natural regeneration of low growing shrubs and herbs on corridor to preserve ecological function. • Clearing and corridor construction should take place after August 15th to avoid nesting season of birds. Where clearing or maintenance cleaning is required prior to this day, conduct a nest survey no more than one week prior to event, and leave 30 m buffer zone surrounding	• Conduct spring and summer 2009 wildlife and vegetation surveys and, if required, develop additional mitigative measures in consultation with regulatory agencies. Mitigation may include alteration of site footprint where economically and practically feasible to avoid terrestrial species at risk; transplantation of individuals; and/or the temporary removal of species.

VEC	Proposed Mitigation	Follow-up and Monitoring
	nests should they be located.	
Recreational and Commercial Fishing	• Establish a 300 m exclusion zone around each of the turbines. • Undertake installation and removal activities outside of lobster fishing season to the extent possible. • Undertake maintenance activities outside of lobster season to the extent possible. • Where activities are required during the lobster season, inform fishers of vessel movements, timing and locations. • Operate vessels in specified routes and locations. • Provide fishers with coordinates of subsea cable and turbines.	• Design and implement lobster catchability studies in cooperation with fishers to identify any changes in catch size.
Archaeological and Heritage Resources	• Stop work and contact the Nova Scotia Museum in the event that archaeological or heritage resources are found.	• Undertake archaeological monitoring during ground disturbance and trenching/excavating.
Tourism and Recreation	• Project to include construction and operation of an interpretative centre at the landfall location.	• N/A

With the implementation of the proposed mitigation measures including development and implementation of a detailed monitoring plan, adverse residual environmental effects of the Project are predicted to be not significant for all VECs. A positive effect is anticipated for recreation and tourism given the potential for an increase in ecotourism.

The potential malfunctions and accidental events associated with the Project were assessed to include spills, vessel accidents/collisions, erosion and sediment control failure, accidental discovery of archaeological or heritage resources, and fires. Emergency and contingency response plans will be developed and included in the Project EMP. Significant adverse effects are considered unlikely to occur.

Cumulative environmental effects have also been considered in the assessment. For the purpose of the assessment and based on consultation undertaken during preparation of the EA, existing fishing and shipping activities are not anticipated to increase throughout the life of the Project. Furthermore, no future development projects or changes to current activities have been identified which are expected to overlap spatially and/or temporally with the Project.

The potential effects of the environment on the Project include extreme weather events, climate change, sea ice and seismic hazards. Seismic hazards, climate change, sea ice and extreme weather are not anticipated to significantly affect the proposed Project provided that infrastructure is designed using the most up to date information to address predicted sea level rise in the region.

10.2 Conclusions

In conclusion, the Tidal Energy Demonstration Facility Project is not likely to have significant adverse effects on the environment. Adverse environmental effects will be reduced to acceptable levels through the use of technically and economically feasible design and mitigation measures.

The Project will contribute to the goals and requirements established in the Provinces' Renewable Energy Standards for the reduction of GHGs and dependence on fossil fuels for generating electricity. In addition, a demonstration project of this nature is required and has been recommended in the Strategic Environmental Assessment (OEER 2008) and the Background Report (Jacques Whitford *et al*. 2008) to gather valuable and much needed information to fully assess the potential environmental effects of tidal energy and tidal in-stream energy conversion technology as a renewable energy source in the Bay of Fundy.

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