INSTREAM TIDAL POWER IN NORTH AMERICA

ENVIRONMENTAL AND PERMITTING ISSUES

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Acronym List

ABPmer.................................ABP Marine Environmental Research Ltd.

AC...Alternating Current

ACEC....................................Areas of Critical Environmental Concern

Act...Electricity Act (New Brunswick)

ALP.......................................Alternate Licensing Process

ANPR....................................Advanced Notice of Proposed Rulemaking

BA...Biological Assessment

BAT.......................................best available technologies

BO...Biological Opinion

Board.....................................Massachusetts Energy Facility Siting Board

CEAA....................................Canadian Environmental Assessment Act

Clean Water Act.....................Federal Water Pollution Control Act

Commission or FERC............Federal Energy Regulatory Commission

COSEWIC.............................Committee on the Status of Endangered Wildlife in Canada

CWA.....................................Clean Water Act

CWS......................................Canadian Wildlife Service

CZM......................................Massachusetts Office of Coastal Zone Management

DELG....................................Department of the Environment and Local Government

DFO.......................................Department of Fisheries and Oceans Canada

DTA......................................Devine Tarbell & Associates

ECPA....................................Electric Consumers Protection Act

EFH.......................................Essential Fish Habitat

EIA..Environmental Impact Assessment

EIR..Environmental Impact Report

EMEC...................................European Marine Energy Centre Orkney

EMF......................................Electromagnetic Field

EMR......................................Electromagnetic Radiation

ENF.......................................Environmental Notification Form

EPRI......................................Electric Power Research Institute

ESA.......................................Endangered Species Act

FA ....Fisheries Act
FERC.....................................Federal Energy Regulatory Commission
FPA ....Federal Power Act
GIS ....Geographic Information Systems
GMRI ....Gulf of Maine Research Institute
GPS ....Global Positioning System
HADD ....Habitat Alteration Disruption or Destruction
HDD......................................Horizontal Directional Drilling
IBOF ....Inner Bay of Fundy
ICD..Initial Consultation Document
IHA ....Incidental Harassment Authorizations
ILP...Integrated Licensing Process
ITS...Incidental Take Statement
kPa...kilopascals
kW...kilowatts
kWh.......................................kilowatt-hours
LOA ....Letters of Authorization
LURC ....Land Use Regulation Commission
MBTA ....Migratory Bird Protection Act
MCT......................................Marine Current Turbine
MDEP ....Massachusetts Department of Environmental Protection
MDIFW.................................Maine Department of Inland Fish & Wildlife
MDMR..................................Maine Department of Marine Resources
MEDEP ....Maine Department of Environmental Protection
MEPA ....Massachusetts Environmental Policy Act
MESA ....Massachusetts Endangered Species Act
MHC ....Massachusetts Historic Commission
MMPA ....Marine Mammal Protection Act
MMS ....Mineral Management Service
MNAP ....Maine Natural Areas Program
MNHESP ....Massachusetts Natural Heritage and Endangered Species Program

MPA......................................Marine Protected Areas
MW ....Megawatts
MWDCA...............................Maine Waterway Development and Conservation Act
MWh ....Megawatt-hours
MWPA ....Massachusetts Wetlands Protection Act
NB Power..............................New Brunswick Power Company
NBDNR.................................New Brunswick Department of Natural Resources
NBPUB ....New Brunswick Board of Public Utilities
NEB......................................National Energy Board
NEPA ....National Environmental Policy Act
NGOs ....Non-governmental organizations
NHPA...................................National Historical Preservation Act
NMCA..................................National Marine Conservation Areas
NMFS...................................National Marine Fisheries Service
NOAA ....National Oceanic and Atmospheric Administration
NOI ....Notice of Intent
NPDES ....National Pollutant Discharge Elimination System
NSDNR ....Nova Scotia Department of Natural Resources
NWPA..................................Navigable Water Protection Act
OCS......................................Outer Continental Shelf
ONR ....Office of Naval Research
OOC ....Order of Conditions
RGU ....Robert Gordon University
RITE ....Roosevelt Island Tidal Energy
ROW ....Right-of-way
RPM ....Reasonable and Prudent Measures
RTT ....Rotech Tidal Turbine
SARA ....Species At Risk Act
TISEC ....Tidal Instream Energy Conversion
TLP ....Traditional Licensing Process
USCG...................................U.S. Coast Guard

USACE ..................................U.S. Army Corps of Engineers

USFWS ..................................U.S. Fish and Wildlife Service

WQC ....Water Quality Certification

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Section 1
Introduction

The Electric Power Research Institute, Inc. (EPRI) and its partners are collaborating with state/provincial energy agencies and utilities from seven states and provinces (Maine, Massachusetts, New Brunswick, Nova Scotia, Alaska, Washington, and San Francisco, California) to define system designs for a demonstration project of tidal instream energy conversion (TISEC) power plants. This project is referred to as the North American Tidal In Stream Energy Conversion Feasibility Demonstration Project, and the overall project objective is to demonstrate the feasibility of TISEC to provide efficient, reliable, environmentally-friendly, and cost-effective electrical energy and to create momentum towards the development of a sustainable commercial market for this technology.

The identification and characterization of promising sites for each state or province is covered in EPRI's corresponding site survey reports (Hagerman et al. 2005*a*, 2005*b*; Hagerman and Bedard 2005*a*, 2005*b*). These reports identified and characterized the most promising sites for a feasibility demonstration project, notionally rated at 500 kW (producing 1,500 MWh annually at 40 percent capacity factor) and for a first commercial plant, notionally rated at 10 MW (producing 30,000 MWh annually at 40 percent capacity factor). For each state and province, a site was selected by state and provincial advisors to assess the feasibility of a demonstration scale and a commercial scale TISEC project.

There are two primary types of TISEC devices: horizontal axis turbines and vertical axis turbines. Unlike typical hydro projects in rivers, these devices are typically free standing and not encased. For this project, horizontal axis turbines were selected to be evaluated for use at all sites. The turbine manufacturers considered for the TISEC project include Marine Current Turbines Ltd. (MCT), Verdant Power LLC (Verdant), and Lunar Energy Limited (Lunar). In addition to discussing the potential general issues and environmental effects for all seven sites, this report discusses potential site- and device-specific issues or effects to environmental resources for each selected site in Maine, Massachusetts, New Brunswick, and Nova Scotia. A detailed discussion of these turbines occurs in a report titled *Survey and Characterization, Tidal Instream Energy Conversion (TISEC) Devices* (Bedard et al. 2005).

There have been no studies conducted to determine the amount of energy that can be converted without potentially adversely affecting the environment. For the purposes of this project, EPRI is limiting the maximum extractable energy to 15 percent of the total tidal energy.

Harnessing tidal energy can have a number of benefits in both environmental and socioeconomic areas. Unenclosed tidal turbines can "...avoid many of the detrimental environmental effects associated with large dams and impoundments, while providing significant amounts of distributed (close to the user), renewable electrical power" (Coutant and Couda 2005). The Energy Policy Act of 2005, which was signed into law in the U.S. on August 8, 2005, promotes the development of cleaner and more productive use of domestic energy sources as well as the diversification in energy supplies through greater use of alternative and renewable fuels. Given the North America energy demands, supply limitations, and energy development goals, the development of tidal energy, which is in its infancy in the U.S. and Canada, represents a way to increase domestic energy production and decrease CO_2 and other emissions by using clean renewable energy sources.

This report assesses the potential environmental effects (Section 2), including potential installation, operation, and decommissioning effects, and permitting issues (Section 3) associated with development of a tidal power project. The methods used to compile potential environmental effects included collecting and researching the existing reports that have been prepared for other marine energy projects. While the wave energy projects are typically farther offshore than the tidal projects discussed herein, certain installation activities and related potential environmental effects are similar and worthy of discussion. There are other marine activities necessary for the installation of a TISEC project which have been practiced for many years like barge anchoring, and pile drilling/driving. There are numerous reports available for the potential environmental effects related to these activities. Conversely, there are literally no reports available which provide environmental effects based on monitoring studies of tidal turbines, due to the fact that this is an emerging technology. In these cases, attempts were made to identify similar activities and provide a comparison of the potential environmental effects that will likely need to be addressed in any environmental permitting activities.

The methods used to compile the permitting issues include identification of the permits, licenses, approvals, and other processes which are likely to be required for the implementation of a TISEC project. The research was conducted by reviewing applicable permit applications, regulations, and guidelines and contacting the respective agencies, as necessary. While there is only one TISEC project that is currently operational (the MCT 300 kW Seaflow experimental unit in the UK), there are many other projects that are currently permitted but not installed, in the permitting process, or recently proposed.

Section 2
Environmental Effects

As with any facility being constructed and operated, a TISEC power plant will have some level of effect on the environment in which it is installed and operates. Because no instream tidal power projects have yet been developed in North America, there are no field demonstrated environmental effects data available at this time (Verdant 2004; Robert Gordon University [RGU] 2002). Identification and assessment of potential environmental effects is based on the general design and turbine configuration (component sizes and arrangements, installation activities, etc.) and comparisons to other similar mechanical devices operated in water such as boat propellers and hydropower turbines which have available data on demonstrated environmental effects. While many of these existing devices are similar in principle, they operate at faster speeds with higher pressure differentials than would a tidal power project (Verdant 2004).

2.1 Background

While there are currently no instream tidal turbines in operation in North America (there is a tidal dam or barrage-type plant in operation in Nova Scotia), some short demonstration testing has occurred. Elsewhere, only the 300 kW MCT and a few small-scale pilot tidal projects are in operation (Scott Wilson Ltd. and Downie 2003). Below, we discuss the status of development for some selected tidal technologies.

In the fall of 2004 Verdant developed and tested a Gorlov Helical Turbine Tidal Power Generation System at a test site on the Merrimack River near Amesbury, Massachusetts. The turbine was developed by GCK Technology and the operating platform, including drive-train, generators, and power conditioning systems, were developed by Verdant (Verdant 2005). The test occurred from October 6 to 22, 2004. Hydroacoustic technology was used to monitor fish movement in the near-field turbine area while the turbine was in operation. However, given the lack of fish found during the study, the results were inconclusive.

Verdant is also in the process of developing a field of underwater turbines in the east channel of Manhattan's East River, along the eastern side of Roosevelt Island. In Phase I of the Roosevelt Island Tidal Energy (RITE) Project, successfully completed in January 2003, a single, small-scale turbine was deployed for three weeks from a barge anchored in the vicinity of the proposed Phase II activities. Verdant is currently engaged in Phase II of the project, which involves the installation of six, full-scale turbines mounted on pilings driven into the river bottom. Testing will be conducted to assess both the efficiency of the turbines relative to their position in the water, as well as the in-situ effects of the turbines on the surrounding environment and marine life (Verdant 2004). No environmental monitoring studies have been conducted because the turbines have not yet been installed. Baseline characterizations have been developed for the following:

- Fish population and passage;
- Substrate profiling;
- Sediment characterization; and
- Benthic habitat characterization.

MCT is completing the 300 kW experimental phase in their development of tidal turbine technology. MCT installed a monopile-mounted experimental 300 kW, single 11-m-diameter rotor system, 3 km offshore from Devon, UK in May 2003. This device has been operational for almost three years. MCT reports that it has conducted measurements relating to environmental effects of the Devon Seaflow unit, including measurements of noise and wake. No negative environmental effects have been visually observed by MCT; however, no study results are currently available.

MCT has completed the design of their Seagen unit; a twin rotor system rated at 1 MW, and it is currently in fabrication. In December 2005, MCT announced that the Environmental and Heritage Service in Northern Ireland has granted consent for MCT's deployment and operation of a Seagen unit in Northern Ireland's Strangford Lough. The unit will be installed and connected to the National Grid during 2006 (MCT 2005).

Lunar and Rotech Engineering Ltd. are developing the Rotech Tidal Turbine (RTT), a ducted single rotor system rated at 1 MW at 6 knots tidal flow and plan to scale that design to 2 MW. A 1/20 scale model Lunar RTT turbine was tank tested at the University of Glasgow Hydrodynamics Test Centre. Lunar is currently in design of the 1 MW unit that will be installed in 2007 at the European Marine Energy Centre where it will undergo operational and commercial development, testing and evaluation.

No significant field assessments of environmental effects of the Seagen or RTT units are known to have occurred.

2.2 General Effects

This section assesses general effects of TISEC project installation, operation and maintenance, and decommissioning.

2.2.1 Installation

This section assesses documented and anticipated environmental effects of installation of a tidal power project. Most of these effects are based on demonstrated effects from common water construction activities and are not unique to TISEC projects. Still, these effects will need to be evaluated and addressed during the environmental review process.

The primary components of a tidal project will be the turbine unit, the transmission cable connecting the turbine(s) to shore, and shore facilities, including substations and any new transmission lines needed to connect to the grid. Effects to resources likely associated with installation include site preparation (drilling and piling of foundations), installing foundations, cable installation, construction of shore buildings, connection to the grid, spoil disposal, and equipment installation (Scott Wilson Ltd. and Downie 2003; EPRI 2004).

2.2.1.1 Aquatic Life

Installation, as well as decommissioning, of a tidal project are the phases most likely to affect the seabed (RGU 2002). Construction effects to benthic habitat resulting from installation of the structures and transmission cable will likely include physical disturbance of the benthos or temporary indirect effects associated with re-distribution of fine sediment (Scott Wilson Ltd. and Downie 2003; ABP Marine Environmental Research Ltd. [ABPmer] 2005; RGU 2002). This in turn may displace aquatic life or change habitat on the seabed or in the intertidal zone. Construction may result in mortality for less mobile species in the immediate project area. Specifically, project construction has the potential to displace or kill benthic organisms in the immediate footprint, and represent a loss of seabed habitat for, the footprint of piling or other turbine structure that anchors the unit to the seafloor[1]. Also, displacement or damage to the benthos may result from the anchoring of ships and barges involved with project construction[2] (ABPmer 2005) and associated anchor sweep (U.S. Army Corps of Engineers [USACE] 2004). Dredge spoils from pile driving or transmission line layout can result in smothering of the benthic community (Scott Wilson Ltd. and Downie 2003) and degrading of the benthic habitat. Many organisms, however, including fish, marine mammals, sea turtles, and birds, are mobile and will be able to move out of the way and/or otherwise avoid the project area during the construction period.

The effect to organisms during construction will depend on the size and nature of the development, the amount of sediment disturbed, the characteristics of the sediment, the installation methods, the number and size of vessels requiring anchorage, and the frequency of anchor lift (ABPmer 2005). Scott Wilson Ltd. and Downie (2003) reported that "the area of seabed affected during construction of turbines and installation of cabling is generally small; current designs for monopiles require a diameter of up to approx(imately) 6 m". While some benthic habitat may need to be removed during installation of foundations or other project structures, construction effects are typically localized and short term (RGU 2002).

There are various methods for installing the transmission cable, and the method selected may be determined by a variety of factors including seabed conditions, marine uses of an area, and preference of regulatory agencies. The transmission cable can be laid along the surface of and anchored to the seafloor. Where burial of the cable is preferred, the method selected will determine the degree to which the seabed is affected. Burying a cable by plowing is another technique used to deploy cable that can minimize disturbance (often less than 1 m wide), while using air jetting may result in disturbance of 1.5 to 4 m width of the sea bed (Scott Wilson Ltd. and Downie 2003; USACE 2004).

Horizontal directional drilling (HDD) is a technique that does not require open trenching and that is frequently used for marine cable projects. With this technique the transmission cable is pulled

[1] Types of TISEC device foundations include: piled foundation (e.g., monopile tripod), gravity foundation (typically, unit is mounted directly to large concrete block), suction cup foundation, and moored (typically dead-weight or embedded) (Previsic and Bedard 2005).

[2] The USACE (2004) reported that a 10,000-pound Danforth anchor, which would be used on installation vessels involved with construction of the Cape Wind Energy Project off of Massachusetts, would have an estimated fluke-tip penetration of about four feet.

through a conduit bored horizontally under the seabed[3]. HDD is often preferred to open trenching, especially in intertidal areas, because it does not expose the surface of the seabed and intertidal zone to wave action, thus minimizing erosion and suspension of sediment. In using HDD, there is a potential for loss or seepage of drilling fluid into the seabed, which may in turn force to the surface resulting in what is commonly referred to as inadvertent release of drilling lubricant or "frac-out". Prevention of drilling fluid release is a major design consideration when determining the profile (or path) of an HDD crossing. In the Draft Environmental Impact Statement for Cape Wind Associates, LLC's proposed Cape Wind Energy Project[4], the USACE (2004) concluded that no adverse effects to fish were expected from use of HDD, which was proposed for the transitioning of the transmission cable to shore.

For proposed underwater transmission cable installation using jet plow technology, the USACE (2004) concluded that the suspended sediments associated with plowing 300 feet/hour would be limited in duration (expected to settle back on the seafloor within one or two tidal cycles) and would not cause harm resulting from smothering or prohibition of feeding to area shellfish, many of which could likely move away from the affected area. The USACE (2004) likened the cable trenching to a storm event "...which causes an increase in suspended sediment load for a short period of time for which clams have the ability to close and survive for the duration of such events."

Scott Wilson Ltd. and Downie (2003) report that "the area affected by the cabling is anticipated to be temporary in nature, and should be re-colonized readily, providing habitat is not patchy in the first place. Selection of the appropriate materials and methodologies should also reduce negative impacts. Scour protection may also be required in certain areas, but again the choice of appropriate construction technique can help to alleviate the need for this." The USACE (2004) reached similar conclusions regarding benthic disturbance resulting from monopole and cable installation:

3 Specialized equipment is used to drill in a substantial pipe conduit along the route of the transmission cable below the seabed. Boring is done with a track-based horizontal boring rig that incrementally adds sections of pipe as the shaft or "drill string" progresses into the ground. When the shaft comes out at its destination, the bit is removed from the end and the transmission cable is attached at that end. The shaft is then pulled back the way it came towards the drilling rig, pulling the cable back with it.

4 The proposed Cape Wind Energy Project includes 130 offshore wind turbine generators, an electrical service platform, and 78 miles of buried underwater transmission cable. The proposed transmission cable system will be buried using jet plowing to at least six feet in depth (USACE 2004).

> *Although some mortality of benthos and shellfish residing in the area of temporary disturbance resulting from monopile and cable installation is anticipated, such impacts would be limited because of the relatively small area of sediment disturbance of a commonly occurring habitat type. In general, it is widely recognized that benthic invertebrates are able to opportunistically invade unoccupied areas after disturbance (Ynes, 1970; Rosenberg and Resh 1993; Rhoads et al. 1978; Howes et al. 1997). For these reasons, the limited area of direct disturbance is unlikely to result in anything more than a localized temporary impact to the benthic community.*

Following installation of the transmission cable, whether by burying or anchoring, there should be little continued effect to the benthos (RGU 2002).

Effects to fish could potentially occur if spawning or nursery grounds are disturbed during construction or if re-suspended sediments causes smothering of habitat (RGU 2002). Direct mortality of juvenile and adult finfish is not expected to result from project construction because their mobility allows them to avoid the project area during the period when construction activities are occurring (USACE 2004). While winter construction could result in increased likelihood of finfish mortality due to sluggish response of fish in cold water, the USACE (2004) expected that marine construction off of Cape Cod would not represent a measurable effect on fish populations. The USACE (2004) further concluded that any effects to fish would be temporary and localized because "...no stressor is likely to extend great distances or for long durations associated with any of the construction activities." As with less mobile benthic organisms, some fish larvae and eggs may be more likely to be affected by project construction, especially from anchor positioning and anchor line sweep (USACE 2004). RGU (2002) indicated that re-suspension of sediment could potentially result in increased food availability for fish, especially pelagic species.

Another potential effect common to all marine construction project is noise and vibration (underwater sound waves). Noise and vibration associated with project construction could include noise from cable deployment and the operation of boats and other equipment. Specific sources of noise and vibration could include: engines; propeller cavitation; other ship-board equipment including continuous (machinery) and impulse (hammering); and construction of device foundations (pile driving) (RGU 2002). These disturbances, as well as the physical presence of construction workers, boats, and equipment, may result in marine mammals, fish, and birds avoiding the project area during construction and disruption of their feeding, migration, and breeding/nesting (Scott Wilson Ltd. and Downie 2003; European Marine Energy Centre Orkney [EMEC] 2005; ABPmer 2005; RGU 2002).

The National Oceanic and Atmospheric Association (NOAA) (2001) reports that "studies of short-term behavioral responses to underwater noise associated with aircraft, ships, and seismic explorations indicate a 0.5 probability that (gray) whales will respond to continuous broadband noise when sound levels exceed ca. 120 dB[2] and to intermittent noise when levels exceed ca. 170 dB, usually by changing their swimming course to avoid the source." The National Marine Fisheries Service (NMFS) indicated that 180 dB is the threshold level for avoiding injury or harassment to marine mammals and sea turtles (Kurkul 2002). A Department of the Navy (2001) study detected some short-term behavioral responses of whales to sound levels of 120 to 155 dB. Noting that "short-term behavioral responses do not necessarily constitute significant changes in biologically important behaviors", the Department of the Navy (2001) concluded that the threshold for potential effect on biologically significant behaviors (level of potential concern) of whales is >145 dB.

The degree of noise effects and disturbance related to increased shipping and presence of workers associated with construction would depend on the type of required construction and support and the duration and timing of the construction as well as the presence of sensitive species and the use of/importance of an area to sensitive species (ABPmer 2005). Noise and associated construction disturbance effects could be negligible resulting in habituation, or cause disturbance or stress leading to avoidance of the project area (RGU 2002).

Richardson et al. (1991) reported that short-term disturbances have not been determined to result in long-term effects on marine mammal populations. During construction of the Nasrevet Wind Farm in Sweden, Westerberg (1999) reported that gray seals quickly became habituated to construction activities, including installation of pilings. The Environmental Assessment Division of the Office of Naval Research (ONR) concluded that noise associated with construction of the Kaneohe Bay wave energy project in Hawaii would be localized, intermittent, and short duration and that installation of the project was unlikely to have adverse effects on humpback whales, dolphins, and green sea turtles (ONR 2003). Whales and sea turtles have also been reported to habituate to the presence and sound of boats (USACE 2004). Any effects associated with project construction would likely represent a short-term effect that would only last for the construction period.

As discussed in more detail in Section 2.4, during project planning, sites should be selected so as to avoid areas inhabited by protected and sensitive species, especially species listed as threatened or endangered under the Endangered Species Act (U.S.) or Species at Risk Act (Canada). However, the presence of these species does not necessarily preclude project development, particularly if adequate mitigation or avoidance measures can be implemented (Scott Wilson Ltd. and Downie 2003). Areas of management or conservation focus, such as kelp beds and submerged aquatic vegetation (e.g., eel grass), should also be identified early in the siting process and avoided if possible.

2.2.1.2 Water Quality

While there are no tidal turbines currently operating in the U.S., the activities involved to install a TISEC facility have been practiced for many years. The potential environmental effects pertaining to water quality associated with construction of a TISEC project can be avoided or minimized with proper planning, assessment of construction methodologies, and review of the bathymetry, composition of the seafloor, and benthos.

During construction, it is possible that construction equipment could release oils or other pollutants or that pile driving associated with deployment of the tidal structures or trenching associated with deploying the transmission cable could result in sediment suspension and increased turbidity. At some sites, there may be a concern that disruption of bottom sediments may result in dispersal of contaminated sediment into the water column, thus potentially causing secondary pollution (Scott Wilson Ltd. and Downie 2003; ABPmer 2005; pers. comm. M. McCann, DTA, November 30, 2005). The potential effect will depend on the number and size of the structures, the characteristics and amount of sediment being affected, and the degree of contamination (ABPmer 2005). Proper procedures for handling and disposal of spoil piles, if generated, will need to be addressed with appropriate regulatory agencies prior to project construction. In addition, grouting or cementing of material during installation may be necessary and represent a water quality concern (RGU 2002). The equipment and methods used for construction of a TISEC project are similar to well-established processes used for construction of other marine development projects, including dock and pier construction and deployment of underwater transmission and communication cables.

For another project involving similar events, the USACE (2004) surmised that sediment disturbance from natural events and fishing gear and that the biological impacts associated with an activity such as the jet plow would be less than those associated with both one tidal cycle and one commercial trawling event. The USACE noted that construction represented a one-time occurrence while trawling takes place regularly over very large areas and tidal cycles occur two times a day. The USACE concluded that minimal short-term and no long-term effects were expected for the construction of the project.

2.2.1.3 Terrestrial life

The planning and installation of transmission line corridors, buildings, and roads on land and shore lands are activities that have long been conducted. The techniques and construction methods used for these activities are well known in the industry. A typical TISEC project may include construction of the following land use components:

- shore station;
- access roads;
- parking area; and
- ROW for connection to the grid.

If establishment of an overhead transmission line is necessary to connect the shore station to the grid, the construction of a ROW, and installation of wires and poles may be required. Typical ROW construction proceeds in an orderly fashion with one operation sequentially succeeding another. The general sequence of work is surveying, development of access roads and vegetation clearing, installation of erosion control measures, pole assembly, pole setting, conductor installation, and clean-up. Construction staging areas may also be necessary to construct the terrestrial portions of the project. Staging areas serve as construction headquarters; material is received, stored, organized and shipped to the ROW from these points.

Anticipated disturbances represented by the activities described above include the disruption of the land and potential wetland disturbance along the route. Construction may result in the permanent removal of some terrestrial habitat (e.g., within the footprint of the shore station, aboveground transmission line ROW, and associated access roads and staging area). Permanent cover-type conversions may occur to forested areas located along the ROW of the transmission line route. The conversion of forested cover types associated with a new transmission line will result from clearing and vegetation maintenance practices. Often, a goal of construction of a ROW is to not alter the hydrology of any wetlands (i.e., no inflow/outflow restrictions) in order to not permanently affect the principal functions such as groundwater discharge or sediment stabilization. Typically, only temporary effects to the wildlife habitat function of wetlands occur during the construction period.

2.2.1.4 Marine/Land Uses

During construction, other marine uses of the area such as commercial fishing, recreation access, and general boat traffic transiting through the project area, may be restricted to avoid collisions, thus representing a temporary disruption to existing shipping and boating uses at a site. Land uses may likewise be restricted and disrupted temporarily during construction of the shore-based components of a project. For example, access to the shoreline in the vicinity of the project or to areas near the construction site may be restricted for safety reasons. The degree of effects will depend on the site characteristics including proximity to shipping lanes, harbor entrances, etc.; the density of ships passing through the area; and the timing of construction.

2.2.1.5 Aesthetics

The presence of construction equipment, storage yards for construction materials and equipment will represent localized aesthetic effects during construction. The effect will depend on the existing use and level of use of the site as well as the characteristics of the site (Scott Wilson Ltd. and Downie 2003).

2.2.1.6 Cultural/Historic

Potential effects on historic properties, such as archaeological sites, resulting from construction may be of concern depending on the location of a project and associated construction staging areas. Because tidal projects will be sited in locations having strong currents, it is expected that the presence of archeological or historic properties of significance are unlikely at the turbine deployment location. Site preparation onshore for the land components of the project (e.g., shore station, transmission ROW) could potentially disrupt cultural sites. Consultation with state historic preservation agencies and other relevant groups during the siting process can help minimize any negative effects by either avoiding sensitive areas or using appropriate methods to minimize potential effects.

2.2.2 Operations and Maintenance

This section discusses potential environmental effects associated with operation and maintenance of a TISEC project.

2.2.2.1 Aquatic Life

Discussed below are potential effects to the aquatic community that may result from TISEC project operation and maintenance.

Mechanical or Flow-Related Injuries

Injuries to fish, marine mammals, diving birds, or aquatic life could potentially occur from coming in contact with a component of the tidal turbine (mechanical injury) or caused by flow characteristics associated with operation of the unit (Odeh 1999; Coutant and Cada 2005; Verdant 2004). TISEC turbines are expected to have minimal effects on fish, marine mammals, and other marine life because:

- the open nature and slower operating speed of a TISEC turbine, as opposed to a conventional hydro turbine or a boat propeller, should not be as harmful to marine life; and
- many marine fish, mammals, and other organisms have high perceptive powers and agility, giving them the ability to avoid collisions.

However, without any studies having been completed, this has not yet been confirmed. The potential effect would vary depending on the type of device and the species inhabiting the project area.

Examples of mechanical and flow-related injuries are summarized below.

- **Mechanical**
  - Impingement (contact with a screen, trashrack, or debris at the intake)
    - Collision injuries with screens
    - Flow "pinning" injuries against screens
  - Contact
    - Strike
    - Abrasion
    - Pinch and grinding (typically associated with fish being drawn into a gap or small clearance)
- **Flow-Related**
  - Pressure gradient (resulting from turbine operation)
    - Differential; in extreme cases, it is called cavitation
  - Water velocity (especially downstream of turbine blades)
    - Shear stress - change in water pressure
    - Velocity over distance
    - Turbulence

Source: Odeh 1999; NMFS 1994; Verdant 2004.

The likelihood of these types of injuries occurring to project area aquatic life is dependent on a number of factors, including:

- Frontal area of the turbine swept area;
- Turbine rotational speed (rpm);
- Tip speed of the turbine blades (feet/sec);
- Number of turbine blades;
- Current velocities that depend primarily on the tidal cycle and weather effects;
- Species, size, and numbers of fish and other aquatic life occurring at the location and depth of the turbine;
- Efficiency of turbine;
- Shape of the blade;
- Smoothness/roughness of turbine components;
- Presence of gaps between moving parts; and
- Presence of a flow diversion component.

Source: Verdant 2004.

The above-listed mechanical and flow-related injuries are typically associated with conventional hydropower facilities, and because of fundamental differences in every aspect of tidal power project design, the potential for many of the effects would be expected to be much less than for conventional hydro projects. For instance, in comparison to conventional hydro projects, tidal projects differ as follows (Verdant 2004; Coutant and Cada 2005):

- There are no physical blockages to inhibit movement of fish and marine life. TISEC systems do not have a confined forebay or penstock into which fish may be drawn into. Most TISEC turbines are open on all sides. However, turbine designs having fixed ducts accelerate flow which may result in fish and aquatic life being drawn through the turbine blade area at least to some degree.
- Fish may be attracted to the accelerating flows that often occur in the forebay or penstock of a conventional hydropower turbine. This may also occur to a lesser degree with TISEC turbines having fixed ducts. In contrast, flow directly in front of an open "windmill"-type TISEC turbine is slowed by the backwater effect of the blades on the tidal current. A slight pressure wave forms in front of the turbine, which will likely direct fish outward and away from the turbine disk. Fish and other marine life are likely to be exposed to less danger because they can move to avoid the turbine.
- Rotor and blade tip speeds of TISEC turbines range from about 10 to 12 m/sec (22 to 27 mph), and are typically much slower than conventional hydropower turbines or boat turbines[5], reducing both the probability of contact, and the probability of injury or mortality.
- The solidity of a TISEC turbine (i.e., the percentage of the rotor-swept area occupied by the blades) is typically less than for conventional hydropower turbines[6]. As a result, fish passing through the rotor-swept area of a TISEC turbine have a much lower probability of contacting a blade.
- Due to the openness of most TISEC systems, there is limited potential for injuries due to abrasion, pinching, or grinding.

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5 For example, an MCT Seagen turbine rotates at 10 to 20 rpm (MCT 2005), a ship propeller that is 6 to 9 m in diameter typically turns at 80 to 100 rpm, and a conventional hydropower Kaplan or fixed-propeller turbine typically operates at 100 to 200 rpm.

6 Conventional hydropower turbines may have solidity up to 90 percent, while the TISEC turbines have the following approximate solidity: Verdant Power's IEGT - 10 percent; MCT Seagen - 4 percent; and Lunar - 30 percent (pers. comm. D. Stewart, Rotech and R. Bedard EPRI, December 7, 2005).

- Changes in water pressure across a TISEC turbine are typically orders of magnitude less than those that occur in many conventional hydropower turbines, greatly reducing the potential for fish injuries. For example, in a conventional hydropower system, the pressure differential can range from about 380 kilopascals (kPa) in a vertical Kaplan turbine to 55 kPa in a horizontal bulb turbine. For Verdant's IEGT turbine, a maximum pressure differential of 2 kPa was calculated.
- TISEC turbines lack draft tubes and wicket gates, confined areas, and gaps through which water flows, which are the causes of many of the shear stresses that occur in conventional hydropower and cooling water systems.
- Turbulence associated with TISEC turbines is orders of magnitude below that of conventional hydropower turbines.
- There is no change in habitat associated with inundating terrestrial areas or wetlands.
- No or comparably little effect on water temperatures and dissolved gases (as can be an issue in reservoirs) and altered sediment movement.
- Little visual effects, especially for devices that are completely submerged.

As previously mentioned, there is a paucity of information as to whether, and if so, to what degree, tidal turbines cause mechanical and flow-related injuries to marine life. In their review of tidal power in the U.K., Scott Wilson Ltd. and Downie (2003) state that "There is no evidence as yet that marine mammals etc. are sucked into the turbines, but this analysis is based upon two pilot scale schemes only, and further research is likely to be required." MCT (2005) noted that many marine organisms that swim in areas with strong currents, where a tidal turbine would be sited, likely have high perceptive powers and agility, giving them the ability to avoid collisions with the relatively slow-moving turbine blades. RGU (2002) stated that risk of collision of fish or marine mammals with turbine blades is thought to be extremely low. Verdant is planning to conduct a hydroacoustic field study to assess potential injury to fish and marine life at the proposed RITE Project in New York.

Organisms present in the water column that have limited or no mobility (jelly fish, icthyoplankton, etc.) likely face higher risk than organisms that are mobile (juvenile and adult fish, marine mammals, etc.) of passing through the tidal turbine stream. Based on a review of numerous studies exposing early life stages of fish to various conditions (pressure changes, blade strikes, and shear forces) to evaluate turbine passage mortality, Cada (1990) concluded that data suggest that turbine-passage mortality for these life stages would be very low or insignificant. In comparison to the conditions typical of low-head hydropower turbines, which were evaluated in these studies, the TISEC technologies would have a negligible effect. The unenclosed area, slow rotation speeds, low solidity of the rotor-swept area, lack of major pressure differentials or velocity changes and shear forces associated with these open-water turbines will minimize any potential for adverse effects to icthyoplankton.

Habitat

While effects to the seafloor associated with plant construction are temporary in nature and are associated with the physical disturbance of the habitat, changes associated with plant operation represent longer term changes associated with the presence of project structures and effects of the plant operation. Colonization of the pilings and other parts of the turbine structure by sessile marine life is likely unless discouraged through the use of anti-fouling agents.

Areas of shelter, structure, or cover are typically sought by fish for protection from predators (Johnson and Stickney 1989) or as velocity refuge in areas of higher currents. Man-made structures such as docks can represent attractive sources of cover and refuge, especially hard substrate having a vertical orientation (USACE 2004) in many marine areas that have comparably little structure associated with the seabed. Colonization by marine life that otherwise would not occur in a particular area, in turn, attracts other predatory fish (Ogden 2005). Sampling conducted before and after installation of the Vindeby offshore wind farm along the Danish Coast found that fish abundance increased and that other flora and fauna generally improved (RGU 2002). As such, the structures associated with a TISEC project may likely provide habitat for fish and other marine organisms similar to those predicted to colonize the proposed wind turbine foundations offshore of Cape Cod including "...algae, barnacles, hydroids, sponges, tunicates, bryozoans, anemones, and possibly mussels....". Following colonization of algae and other fouling organisms, other sea life including crabs, gastropods, nudibranchs, and marine worms may use project structures (USACE 2004). As Ogden (2005) noted "It is still an open question if such structures add substantial new productivity and therefore increase the populations of marine organism. Certainly, they attract and concentrate naturally occurring populations from a potentially wide area, depending upon the size of the structure." It is also unknown if the turbulence, potential for injury from contact with the rotor, etc. would offset gains in increased habitat with regard to potential increases in abundance of project area marine organisms. For the pilot TISEC projects, and possibly for the commercial scale projects, it is unlikely that the project structures will represent a substantial increase in patch reef habitat.

Project components, including the transmission cable, may likely provide structure to invertebrates and macro algae, thus providing for development of artificial reef habitat along the cable route. Fishing exclusion zones will likely be required around project facilities, which in turn may result in the project serving as a "no take zone". The exclusion of trawling and other fishing from the project area, especially a larger project area that would be associated with a commercial-scale project, combined with the "artificial reef" effect of project structures, may serve to benefit area fish stocks and the aquatic community (ABPmer 2005).

Any above-water portions of the project may be used by roosting birds or, if accessible, as haul-out areas for pinnipeds. As with the artificial-reef effect of underwater portions of the project, if development of a commercial-scale project resulted in creation of a substantial amount of additional above-water structure, it may enable larger populations of seabirds and marine mammals to exist in the project area over the long term than would under natural conditions. Presence of pinnipeds or nesting sea birds on a project structure could also complicate periodic device inspection and repair (EPRI 2004).

Because the initial phase is a pilot project, it is anticipated that maintenance requirements will be greater than for the commercial phase. Similar to Scott Wilson Ltd. and Downie's (2003) review of tidal projects in the U.K., initial testing may require repositioning the units, which will affect the benthos. Periodically, it may be necessary to bring in a barge or raise a tidal unit to perform major maintenance. Effects to resources from maintenance could include localized disturbance of the benthos and would be dependent on the size of vessels requiring anchorage, and the frequency of anchor lift (ABPmer 2005). It is expected that methods for conducting a repair to the cable system (USACE 2004) or turbine will be similar to those used for construction or decommissioning. Though dependent on project and device-specific conditions, as with construction of the projects, it is expected that any effects would be minor, localized, short term, and reversible (Scott Wilson Ltd. and Downie 2003; USACE 2004).

Another potential effect may include the extraction of tidal energy. There is not enough information available at this time to evaluate, but it is likely this would depend on site characteristics and the type and number of tidal energy units. Any project effects to project area important fish habitat (e.g., Essential Fish Habitat [EFH] in the U.S.) and marine mammal habitat or migration routes will be of concern for development of a TISEC project[7].

Entanglement/Entrapment

While some marine mammals may become entangled in fishing gear (e.g., harbor porpoises in gill nets; right whales in lobster pot lines), entanglement is not expected to be an issue at a TISEC project because fixed gear associated with these device would not risk entanglement of passing sea life. However, the potential for entanglement should be considered if the project includes moorings, such as navigation buoys, or other components that could wrap around marine mammals, diving birds, or other marine life. Entrapment may be of concern if the transmission cable runs along the seabed surface. However, this risk can be minimized by ensuring that the cable is anchored in such a way as to provide maximum contour to the seafloor (reducing spaces where marine mammals can become trapped) or by burying the transmission cable.

Predator-Prey Interactions

Increased fish predation by other fish and marine life could potentially occur as a result of the following (Verdant 2004):

- Fish injury due to mechanical or flow-related injury;
- Fish disorientation resulting from turbulence;
- Attraction of prey species, and thus predator species, to flow refugia formed by structures; or
- The creation of more habitat for aquatic life, including both prey and predators.

Operation of a tidal unit, especially many tidal units in a commercial facility, could potentially hamper migration of fish, marine mammals, and other marine life (Coutant and Cada 2005). In

[7] In the U.S., the Magnuson-Stevens Act mandates the identification of EFH for managed species as well as measures to conserve and enhance the habitat necessary for fish to carry out their life cycles. The Magnuson-Stevens Act requires cooperation among NMFS, fishing participants, federal and state agencies, and others in achieving EFH protection, conservation, and enhancement.

addition, development of a large project could potentially result in re-distribution of certain marine organisms, with some species or life stages avoiding the area or being prone to injury or mortality from the turbines, while others may habituate to or even be attracted to the area (RGU 2002). With regard to this latter point, as discussed above, the structures associated with a TISEC project may likely provide fish habitat, perhaps even serving as an artificial reef. While these effects may be minor for a pilot scale project, a number of units that would likely be built for the commercial phase may result in larger numbers of fish, birds, and marine mammals being attracted to the project area to feed upon an expanded prey base. This in turn could result in increased potential for injury by a turbine blade. If a redistribution of species occurs in the area of a tidal project, resulting in some species/life stages increasing in abundance while others decrease, this in turn could translate into a shift in composition and make-up of the marine community, possibly even changing the marine ecology of the area. The degree to which this would occur, if at all, is unknown, though like many potential effects, it would likely vary depending on the type of tidal turbine technology used, the site characteristics, and the size of the units and of the development.

Noise and Vibration

Operation of TISEC projects will result in noise and vibration, the amount of which would be device-specific. Underwater noise for TISEC units has not been quantified, but it is expected to be relatively low because of the low speed of operation, especially in comparison to a boat propeller, and the need to minimize cavitation (Bedard et al. 2005). Coutant and Cada (2005) report that it is not expected that tidal turbines would create a lot of noise. Scott Wilson Ltd. and Downie (2003) state that noise and vibrations can affect fish behavior and cause them stress. Fish and marine mammals are sensitive to noise in the water column. The sensitivity is dependent upon the noise frequency, sound power level and duration (Metoc 2000). The severity of potential noise effects will depend upon whether there are sensitive receivers in the area. Excessive vibration could cause marine mammals, fish, and birds to avoid the project area, could disrupt their feeding, and/or in the case of birds, could disrupt their nesting (Scott Wilson Ltd. and Downie 2003, EMEC 2005). However, some noise may be beneficial in alerting fish and marine life to the presence of the project so that they can avoid the turbine (Coutant and Cada 2005).

Gray whales have been found to readily acclimate to noise associated with the offshore oil industry production platforms (Richardson et al. 1991). The USACE (2004) reports accounts of dolphins and fish becoming habituated to vibration associated with offshore wind farms. They also concluded that increased boat traffic and associated vibration associated with project operation would likely not adversely affect finfish or their prey (USACE 2004). The ONR (2003) concluded that it was unlikely that the Kaneohe Bay wave energy project would have adverse effects on humpback whales, dolphins, and green sea turtles.

While one noise may not have an effect on marine mammals, “the presence of multiple noise sources in an area may increase the severity of any adverse noise effects resulting from single sources. This in turn creates implications for tidal farms in critical areas.” While there is evidence of considerable tolerance of marine mammals to repeated human activities, there is also evidence of decreased numbers of marine mammals in areas with heavy human use (RGU 2002).

At any site selected for development of a TISEC project, an assortment of existing vibration will already occur including ambient wave/ocean noise and boat traffic. Gerstein (2002) reports that noise studies conducted on boat propellers indicate that frequencies can range from less than 1,000 hertz for a boat that is traveling slowly to 20,000 hertz for a boat traveling at high speed and causing cavitation.

Electromagnetic Radiation

Any generation or use of electricity results in the presence of electric and magnetic fields. Electromagnetic fields (EMF) diminish rapidly in size with distance from the source (USACE 2004, World Health Organization 2005). Electric fields can be shielded, or attenuated by objects. While magnetic fields penetrate most materials, they drop off quickly with distance (USACE 2004).

Sources of electromagnetic fields produced by a TISEC project include the generator and the transmission cable (Verdant 2004), which transport the generated electricity to shore along or under the seabed. Scott Wilson Ltd. and Downie (2003) state that “The artificial magnetic and electric fields (associated with submarine electric cables) can cause interference and disturbance to orientation in migrating animals and with the feeding mechanisms of elasmobranchs (group of fishes which includes the sharks, rays, and skates). ...at the present time it is not clear as to the significance or scale of these impacts.”

The underwater transmission cable for the Kaneohe Bay wave energy project was designed to carry 250 kW (ONR 2003). For that project, the ONR determined that "The small scale and limited area of disturbance indicate that impacts from electromagnetic radiation (EMR) on marine organisms would be minor and temporary. Impacts of EMR on marine organisms can be expected to range from no impact to avoidance (for bottom-dwelling organisms only) (in) the vicinity of the WEC cable" (ONR 2003).

The Danish Institute for Fisheries Research (2000) concluded the following regarding effects to fish from large offshore windmills:

> *Magnetic fields from cable (routes) ..., windmills, and the offshore transformer station may be expected to reach geomagnetic field-strength levels only in the immediate vicinity of these structures, at distances no more than 1 m. Cartilaginous fishes (sharks and rays) are, by way of their electro-receptive sense organs, able to detect magnetic fields, and they may use the geomagnetic field for navigation. For bony fish, a true magnetic sense has been proposed, but the evidence is much less compelling. Thus, the weak magnetic fields… are not expected to pose any serious problem for the local fish species. Furthermore it does not appear likely that the magnetic fields generated by the power transmission cables will have any detectable effects on the harbor porpoises and seals in the area.*

Transmission cables using an alternating current (AC) system, which is the primary system used in North America for electricity supply, would not result in measurable deflection of compasses or disruption of radio, GPS, or radio-beacon navigational equipment on ships passing over the cables (USACE 2004).

The number and strength of the transmission cables, the type of cable used and the type of cable sheathing, and the depth at which the cable is buried represent factors that will influence the degree to which sensitive species are affected by EMF (ABPmer 2005). The proposed Cape Wind Energy Project underwater transmission cable system would contain grounded metallic shielding that would block any electric fields generated by transmission of electricity through the cable system. Thus, the USACE (2004) concluded that the project would not result in any adverse effects to the aquatic community from electric field effects[8]. The USACE (2004) reported that "the actual magnitude of typical 60-Hz magnetic fields in the vicinity of the (proposed project) submarine cables is, in most locations, many fold below that of the steady geomagnetic field (~500 mG)" from the earth and the maximum exposure would occur over "...an extremely small space, and decrease rapidly within a few feet of such locations....". The USACE (2004) concluded that the there were no anticipated adverse effects to fish species or the marine environment resulting from the 60-Hz magnetic fields that would result from the operation of the project.

The World Health Organization (2005) reports that while "some investigators have suggested that human-made EMF from undersea power cables could interfere with the prey sensing or navigational abilities of (electrosensitive fish such as sharks and rays) in the immediate vicinity of the sea cables... none of the studies performed to date to assess the impact of undersea cables on migratory fish (e.g., salmon and eels) and all the relatively immobile fauna inhabiting the seafloor (e.g., mollusks), have found any substantial behavioral or biological impact."

Threatened and Endangered and Sensitive Species

As discussed above, potential effects (noise, habitat disturbance, etc.) could negatively affect some fauna that inhabit the project area. For example, operation of a project may affect an organism's habitat or cause it to change its behavior. Increased boat traffic associated with project operation may cause marine mammals, sea turtles, or other marine life to tend to avoid the project area and could increase chances of injury to larger marine animals from ship strikes. Any negative effects of project operations on threatened, endangered, or sensitive species will need to be considered in development of a TISEC project. Depending on the level of anticipated effects, resource agencies may require changes to project siting and/or operations.

2.2.2.2 Water Quality

While no studies have been conducted to determine the potential water quality effects associated with the operation of a TISEC project, the free-spinning rotors of a TISEC project present a

[8] The proposed transmission cable system for the Cape Wind Energy Project will be buried to at least six feet in depth and consist of a three-core solid dielectric AC cable design containing grounded metallic shielding that will block any electric field generated by the cabling (USACE 2004).

relatively minor disturbance to the dynamics of the existing tidal current. TISEC units may contain petroleum-based substances such as gear-oil or axle grease. If damage to a gear box or other part of a unit occurred, leakage of these fluids may occur resulting in water contamination. Severe storms or hurricanes provide the increased potential to cause damage to project components and result in larger scale release of lubricants (Ogden 2005). Ambient contaminants sequestered in the sediment could also potentially be re-suspended in the water column due to project operation (Coutant and Cada 2005) if project operation resulted in scour of bottom sediments.

Verdant (2004) determined that operation of their IEGT turbines resulted in no thermal effects to the environment. For conventional hydro projects, which have turbines that operate at much higher speeds than tidal units, thermal effects of concern usually relate to temperature stratification in impoundments and cold water turbine discharge from deep water intakes. These effects do not relate to tidal power projects. Additionally, because TISEC projects will be sited in marine locations having strong tides, the project area waters should not be stratified, but rather be well mixed.

For projects located in more riverine or protected (i.e., harbors) areas, DO, or salinity stratification may naturally occur because of development of temperature and/or salinity gradients, particularly in summer. There is a potential that some young lifestages of fish that may depend on the salinity wedge to transport into nursery areas could be affected if the turbine operation significantly disrupts this wedge.

Transmission of electricity through cables results in heat emissions. The USACE (2004) concluded that thermal effects from the underwater transmission cables associated with that project would be on the order of fractions of a degree, may not be measurable, and as such would represent negligible effects to the aquatic community. For the Kaneohe Bay Project (wave energy) transmission cable, designed to carry 250 kW, the ONR (2003) concluded that there would be no effects to marine life resulting from potential heat release.

In order to maintain the tidal units efficiency, portions of the units will need to be kept free of fouling marine growth. Anti-fouling paints, which may likely be used to reduce bio-fouling, can also be toxic. They tend to leach out over time and can cause localized pollution problems. However, the EPA and U.S. Coast Guard (USCG) have approved a number of anti-fouling coatings (Verdant 2004; Scott Wilson Ltd. and Downie 2003; ABPmer 2005). EPRI (2004) reports that:

If fouling control is necessary, than it can be accomplished either by periodic cleaning (requires divers) or the use of antifouling coatings (requires drydocking). If the coating option is selected, then the use of an organotin compound, such as tri-butyl tin (TBT), would almost certainly be considered, since it entails a recoating interval of six to seven years, compared with one or two years for copper-based paints. (Champ and Pugh 1987) presents a complete review of the environmental problems and legal regulations associated with the use of organotin coatings. The typical legal limit for average TBT release rate is 5 micrograms per cm^2 of hull wetted surface area per day. U.S. Navy experience has been that release rates well below this level (on the order of 0.1 micrograms/cm^2/day) are fully effective in preventing hard fouling. Therefore, even if antifouling coatings are required …, an environmentally acceptable solution to the problem appears to exist.

2.2.2.3 Hydrodynamics

TISEC turbines can be viewed as semi-permeable objects in the tidal current, blocking a portion of the flow and allowing the remaining flow to pass through (Verdant 2004). A tidal project generates power by extracting energy from the tidal current. Potential effects resulting from the extraction of energy and the physical presence of the structures in a high flow environment could include the following (ABPmer 2005; RGU 2002):

- changes in tidal energy (and consequently - effects on erosion, sedimentation patterns, and suspended sediment), including:
  - changes in current flow/velocity
  - creation of turbulence and velocity shadows
  - reflection and diffraction of waves
- direct alteration to the area ecology (alteration of substrate type);
- scour around structures with loss of soft sediments;
- changes in vertical mixing (and possible implication for plankton, water quality, etc.); and
- changes in area geomorphological features.

The degree to which turbine structures modify currents or result in changes to siltation patterns is difficult to predict and will be dependent on the number, size, and type of the units deployed, the site characteristics (including where the unit is deployed, the depth at which the unit is deployed, and the distance from the coast), and the physical processes occurring at the site (ABPmer 2005; Verdant 2004).

In areas having strong currents, which is important to siting tidal generating units, deposition of sediment is typically low (Verdant 2004). Scott Wilson Ltd. and Downie (2003) indicate "…tidal generators are likely to be located in high-energy areas, reducing the likelihood of impacts upon tidal movements, sediment transfer and benthic communities". Tidal turbines will cause turbulence downstream and may cause scour of the seabed if the unit is located near the bottom (Coutant and Cada 2005). Scour is the process where seabed material is eroded and removed due to the hydraulic impact from currents and/or waves. The presence of an obstruction on the seabed causes the flow to accelerate around it, which in turn results in a scour hole surrounding the object (Previsic and Bedard 2005). Specifically, the potential for scour caused by or occurring around the turbines, or by currents passing over the transmission cable may be a concern at sites having a seabed that is sensitive to scouring. As indicated above, in areas having strong currents where tidal generating units are likely to be deployed, the seabed may likely be well armored. Scour therefore may not be an issue because there may be no loose or fine sediment that is susceptible to scour (Scott Wilson Ltd. and Downie 2003, Coutant and Cada 2005).

Many tidal units may cause currents to slow downstream of the unit because the turbine results in energy being removed from the water as it passes around the unit, similar to a stream eddy downstream of a rock. This is referred to as a velocity shadow.

Potential project effects on selective tidal stream transport, the movement of larvae vertically within the water column to use predictable tidal flows in order to remain in or enter estuaries (Forward and Tankersley 2001), may also need to be considered.

2.2.2.4 Marine Uses

EPRI, in its discussion of conflicts with other uses of sea space in a report entitled *Offshore Wave Power in the U.S.: Environmental Issues* (EPRI 2004), highlight marine uses that may also be affected by development of a tidal power project.

From an economic standpoint, the most important uses of near shore and shelf waters where a wave power plant might be deployed are offshore fossil-fuel production and commercial fishing (including kelp harvesting). The revenues associated with coastal recreation and tourism are also significant; although visual intrusion is the most obvious conflict, sport fishing and recreational boating might also be adversely affected by large-scale wave power development. Use of coastal sea space by commercial shipping traffic and for military exercises or scientific research represents other potential sources of conflict. Finally, the designation of certain ocean areas as marine sanctuaries may preclude wave power development within their boundaries.

In addition to the major activities described above, coastal sea space is also used by submarine communications cables, municipal wastewater outfalls, and designated dump sites. These are so highly localized and few in number that they are not expected to significantly limit wave energy's development potential. Nevertheless, when actually siting a wave power plant, these should be identified early enough so that they can be avoided.

Below, we further discuss potential implications of tidal energy development with regard to other marine uses.

Commercial Fishing

It is expected that a fishing exclusion zone will likely be needed to be established around a TISEC site to prevent damage to the project. If the transmission cable is not buried, the exclusion zone would likely have to include the cable route as well. This could potentially disrupt commercial fishing in the vicinity of a TISEC site. The transmission cable may pose a hazard to boat anchors and fishing gear, both of which may become entangled. The maintenance of a fishing exclusion zone around the project may serve as a refuge for juvenile fish and other marine life. Considering that the project structures may provide increased habitat to invertebrates and macro algae, the project may result in increased productivity and diversity of the areas aquatic community (ABPmer 2005).

Recreation

Minimizing visual effects will be of great consequence to areas where tourism or aesthetics are especially important (EPRI 2004) (visual effects are further discussed in Section 2.2.2.5). Depending on the size of the tidal unit and the depth at which it is deployed, recreational boating may also need to be excluded from the project area. Establishing a boating exclusion zone around a TISEC site could potentially disrupt recreational use, including boating, fishing, and swimming, in the area. However, depending on the selected technology and the location and seabed configuration of a given site, smaller recreational boats may be able to traverse a TISEC site. The presence of renewable marine energy projects may result in increased tourist visitation and thus provide green tourism opportunities (ABPmer 2005).

Navigation/Commercial Shipping

Project features (the tidal unit themselves, moorings, etc.) could represent navigation obstacles depending on available clearance and a boating exclusion zone may be needed to be established around a TISEC site to minimize risk of collision. The need for and the area of an exclusion zone would be dependent on the type of TISEC technology selected, the location and seabed configuration of a given site, and site-specific safety regulations. It may be possible to design a tidal plant where the top of the rotor blade is always below the navigation clearance at lowest astronomic tide (LAT).

In the event that the transmission cable is not buried, there will be a risk that ships anchors or fishing gear may become entangled, potentially causing damage to gear and the transmission cable. To minimize this risk, a boating exclusion zone may need to be extended along the transmission cable route.

A developer should consult with the U.S. or Canadian Coast Guard and appropriate state and provincial agencies to minimize effects to navigation, especially if siting of a tidal turbine is proposed near major and minor shipping lanes, or near harbors and ports. The major project features should be marked on nautical charts. The devices would thus represent additional aids-to-navigation in the project area assisting boats navigating in the project area. Some device to shore communications could disrupt normal shipping communications (EMEC 2005). If a project structure became loose and moved, it may create a navigation hazard (ABPmer 2005).

Other Marine Uses

Other potential marine uses that may need to be considered in developing a tidal project include (EPRI 2004; Ogden 2005):

- Aquaculture;
- Designated conservation areas (e.g., National Marine Sanctuaries, National Seashores, fisheries management areas);
- Scientific research reserves (typically state-designated in the U.S.);
- Existing utility use - e.g., pipelines and cables, wind power, wave power;
- Offshore oil and gas;
- Mining and dredging;
- Military warning areas, weapons testing; and
- Homeland security-sensitive areas.

2.2.2.5 Terrestrial

All energy projects connecting to the power grid will have similar long-term environmental concerns and project impacts to terrestrial resources are not unique to tidal projects. If overhead transmission lines are required to connect the project's shore station to the grid, periodic cutting of vegetation will likely be required along the transmission line ROW. In general, a low, healthy, diverse, dense ground cover is usually desirable along transmission line ROWs. This results in a utility corridor that provides good cover for small animals and birds, significant browse habitat for larger mammals, and prevents soil erosion and the resultant sedimentation of water and wetland resources.

Routine vegetation maintenance of the overhead transmission line ROW will be necessary to maintain access for emergency repairs, general maintenance tasks, and facilitate ROW inspections. Once woody vegetative growth is under control, follow-up maintenance activities during operation of the line require only the selective removal of "capable species", dead or danger trees. During the routine vegetation maintenance after construction, the mechanical means of maintaining the height of vegetation on the ROW generally consists of hand cutting, with limited use of motorized equipment. The general procedure is to cut all capable species and any danger trees at ground level and top other vegetation that has the potential to interfere with the safe operation of the line.

2.2.2.6 Aesthetics

Development in coastal areas typically is sensitive due to the aesthetic values associated with these areas. Consequently, parts of the project that are visible from the coast or from sea may alter the landscape qualities of particular views (European Marine Energy Centre Orkney [EMEC] 2005). Potential visual receptor of both land and marine-based components of a marine energy generating project could include: residents, tourists, walkers, cyclists, motorists, swimmers, fishermen, surfers, and boaters (ABPmer 2005). In its review of potential effects of marine renewable energy projects in Wales, ABPmer (2005) state that "A change to a view in itself is not important, unless the change can be translated to changes in the likely attitude or behavior of visual receptors to such changes. It may therefore follow that small changes to one view may be very significant, whereas a large change to another view may not be."

While visual appearance of tidal turbines are site and technology specific, the selected TISEC technologies (Verdant, Lunar RTT, and MCT Seagen - discussed further in Section 2.3) are all located underwater, and therefore the turbines themselves should have negligible visual effects.

If part of a project extended above the water surface, it would likely have to be well marked using navigation lights and high contrast colors for above-water structures for navigation safety. Lights, sound signals, and radar reflectors, and high contrast day-markers may be required. EPRI (2004) reports "The U.S. Coast Guard specifies that such markers be in the form of a diamond-shaped sign, three feet by three feet (0.9 m on a side), with black lettering on a white background and an orange reflective border. While such a sign meets the requirement of being visible within one nautical mile (1.8 km), it would be below the perceptual threshold of most observers beyond a distance of four nautical miles (7.4 km)". Navigation lights can typically be seen for a distance of two to 10 nautical miles (ABPmer 2005).

Shore-based facilities and grid connections will represent a visible ongoing presence, and as such, represent potential visual effects (Scott Wilson Ltd. and Downie 2003).

2.2.2.7 Cultural/Historic

Because tidal projects will be sited in locations having strong currents, it is expected that the presence of remains of archeological or historic significance (e.g., wreck sites, archaeological artifacts, etc.) are unlikely at the turbine deployment location. The operation of the tidal project is not expected to affect areas of cultural or historic significance.

2.2.3 Decommissioning

Because the development of instream tidal energy is just beginning, it is uncertain what the lifespan of a tidal unit would be. As indicated by offshore oil and gas structures, monopiles and support structures can last for more than 40 years. For the Seagen units, steel piles and other primary structural components have cathodic protection and the rotor is constructed from glass and carbon fiber reinforced composite materials that are not significantly affected by seawater (MCT 2005).

Decommissioning effects are likely to be similar to those for project construction (Scott Wilson Ltd. and Downie 2003; ABPmer 2005). Disturbances associated with decommissioning may include removal activities, physical presence of people and equipment, noise, vibration, effects to and loss of benthic habitat, and disposal of removed structures (Scott Wilson Ltd. and Downie 2003; RGU 2002). The USACE (2004) concluded that, during decommissioning of an offshore wind energy project, specific effects from removal of transmission cables, turbine foundations, and other project features as well as the anchoring of construction vessels, may result in temporary re-suspension of seabed sediments similar to project construction. The USACE (2004) concluded that noise associated with removal of monopiles and cable will likely be less than levels that occur during the pile driving during the construction phase. Removal of project facilities may disrupt seabirds or pinnipeds that have become accustomed to their use for nesting or hauling out, respectively (EPRI 2004) and to finfish that are attracted to structure-oriented habitat (USACE 2004).

2.3 Site-Specific Effects

This section of the report assesses site-specific effects for sites located in Nova Scotia, New Brunswick, Maine, and Massachusetts. Site-specific effects are dependent on characteristics of the physical environment, aquatic and terrestrial community, and existing uses of the area as well as the device selected for use at each site. In this section, potential environmental effects of installation, operation, and decommissioning of tidal projects are identified for each of the selected sites.

Site selection for each province and state was determined by considering tidal conditions, channel depths, seafloor properties, grid interconnection, maritime infrastructure, and environmental issues. These findings were presented in summary reports characterizing potential project sites in each province and state (Hagerman et al. 2005*a*, 2005*b*; Hagerman and Bedard 2005*a*, 2005*b*).

Based on an evaluation of all available technologies, for the initial pilot scale project, three types of tidal turbines, all horizontal axis turbines were selected by the state/provincial advisors for consideration for use at the Nova Scotia, New Brunswick, Maine, and Massachusetts sites. Unit selection for each selected site was determined primarily on economics and is as follows:

- Nova Scotia MCT Seagen or Verdant
- New Brunswick Lunar RTT or MCT Seagen
- Maine MCT Seagen, Lunar RTT, or Verdant
- Massachusetts MCT Seagen, Lunar RTT, or Verdant

2.3.1 Device Overview

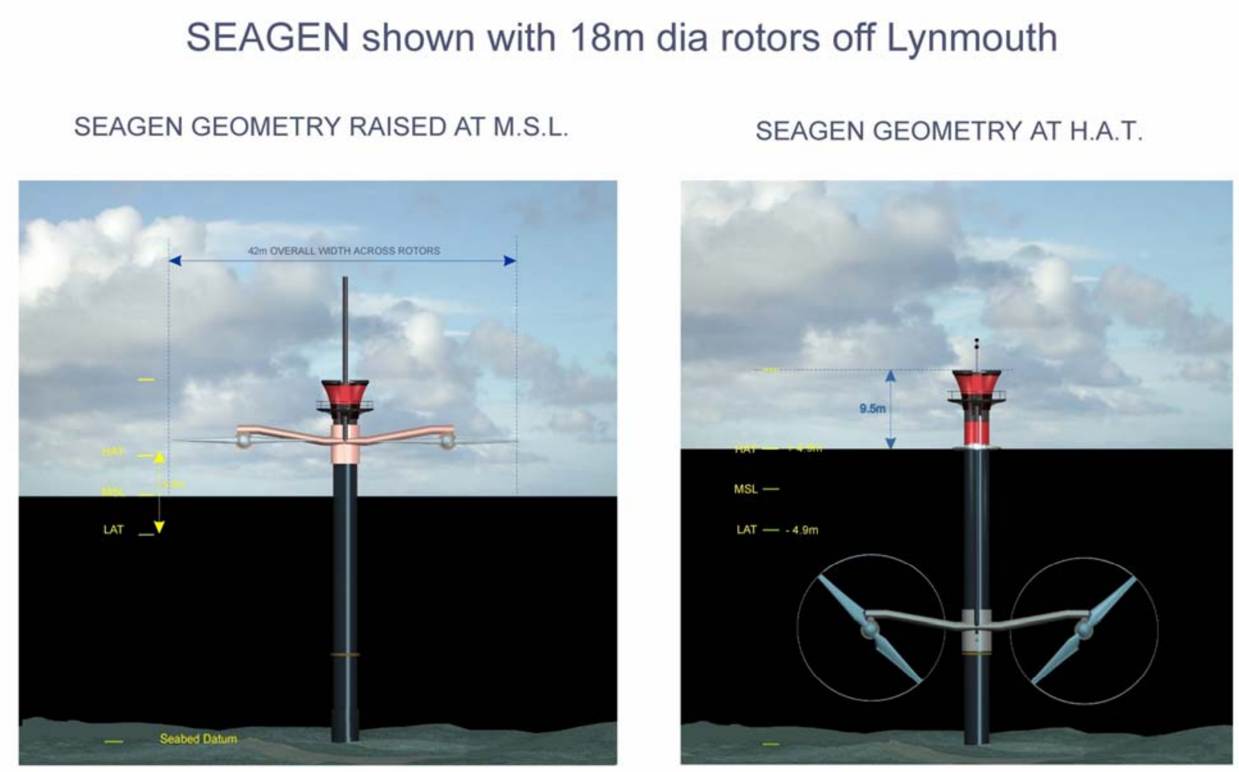
The three turbine types selected by the EPRI team are briefly described below[9].

2.3.1.1 MCT Seagen

This MCT Seagen prototype is a dual turbine unit with each rotor being 18 m in diameter. An illustration of the MCT Seagen is shown in Figure 2-1, though a modified version which will not extend above the water surface is being proposed for the EPRI projects. Rated power is 1.5 MW. If these dimensions prove too large for a site, the unit can be scaled down.

[9] In a report entitled *Final Survey and Characterization, Tidal In Stream Energy Conversion (TISEC) Devices*, Bedard et al. (2005) discuss the specifications of each of these three TISEC turbines in greater detail.

FIGURE 2-1
MCT SEAGEN TISEC TURBINE

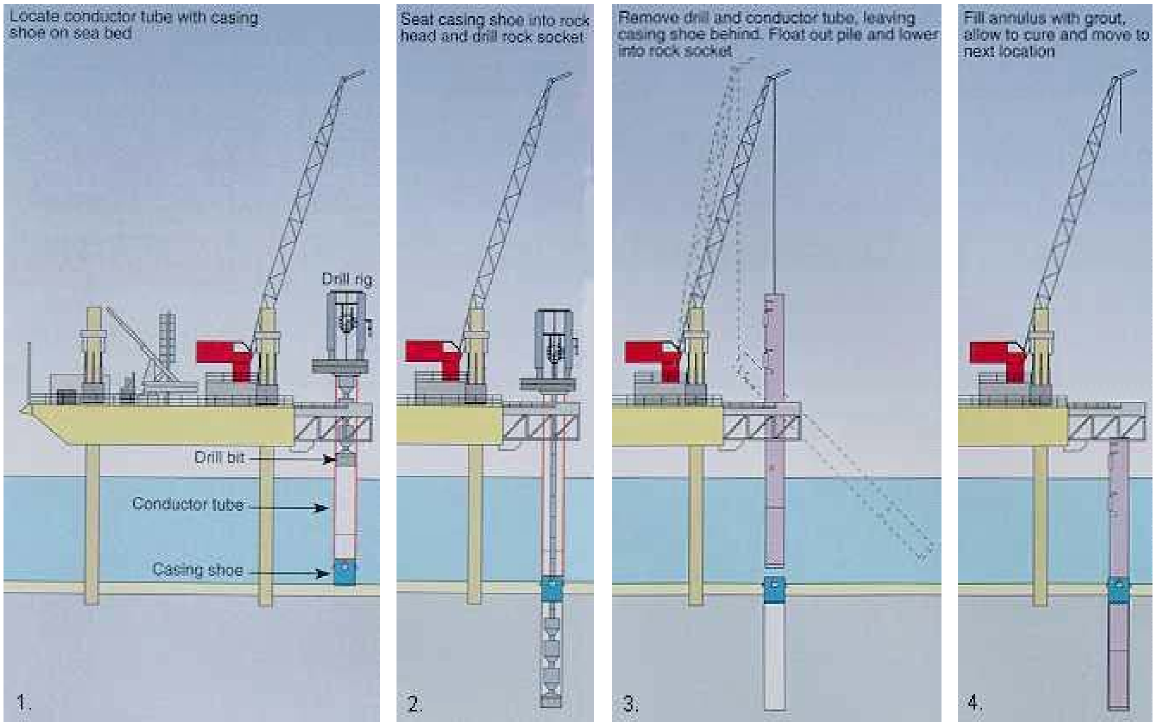


The MCT Seagen may employ a monopile foundation, as is commonly used for offshore wind energy projects in Europe. One of MCT's founding investors is Seacore, Ltd., a UK-based company specializing in non-oilfield marine drilling. Seacore (2005) has installed monopile foundations for at least five offshore wind energy projects, as well as MCT's Seaflow project (Hagerman et al. 2005*a*). Seacore indicated that their monopile technology has been applied mainly in firm seabeds of rock or hard clay (Seacore 2005). Any sediment overburden is drilled through and the monopile would be grouted into a socket of 15 to 20 m penetration depth into the underlying bedrock (Figure 2-2).

2.3.1.2 Verdant

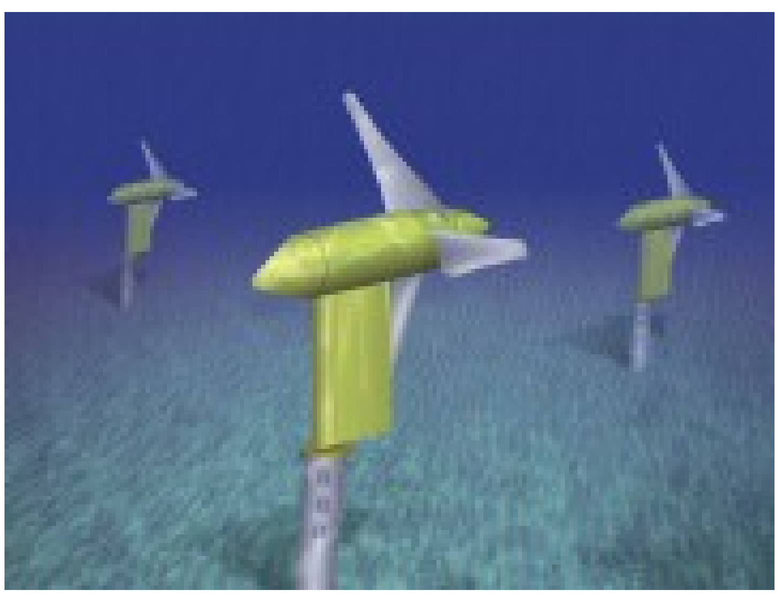
The Verdant turbine is a 5-m-diameter single-rotor (Figure 2-3). Each unit is rated at 36 kW at 2.2 m/s. The major marine deployment steps for a Verdant turbine include drilling and setting piles using jack-up barge; setting turbines — divers bolt the fixed pylon turbine mounting flange via an adapter to a reinforced pile that has been drilled and grouted into the rock bottom; and running cables also using weighted divers (Bedard et al. 2005).

FIGURE 2-2
MONOPILE FOUNDATION INSTALLATION SEQUENCE



Source: Seacore 2005.

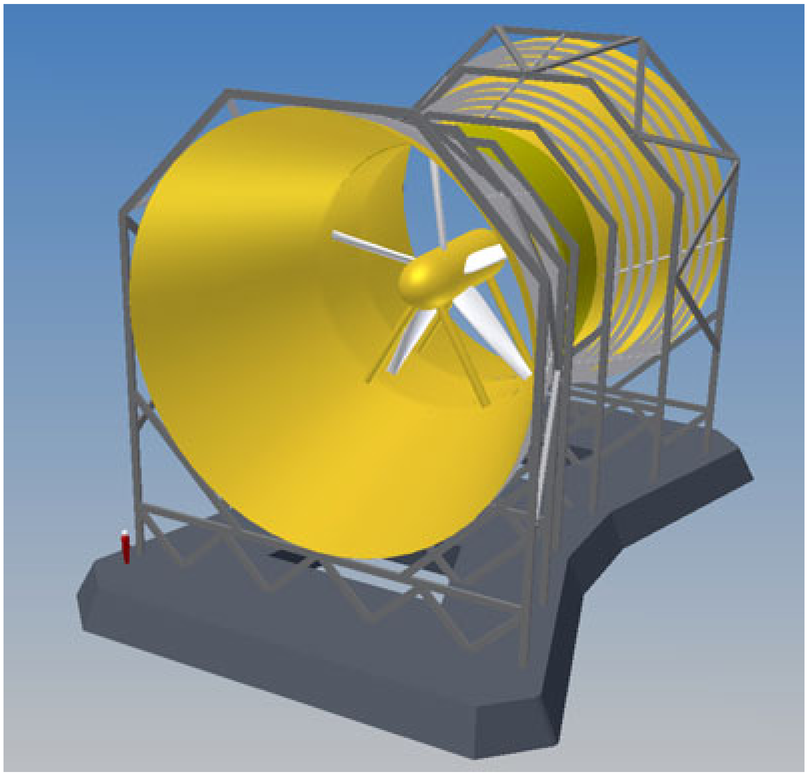
FIGURE 2-3
VERDANT TISEC TURBINE



2.3.1.3 Lunar

The Lunar RTT 2000 is a 25-m-diameter (duct inlet) single-rotor device (19.5 m diameter with a 3.9-m-diameter hub) (Figure 2-4). The unit, including the base would be about 32 m high and 30 m long and would weigh about 2,500 tons. One unit is capable of producing 2 MW from a 3.1 m/sec current. If these dimensions prove too large for a site, the unit can be scaled down. To achieve the pilot phase goal of producing 500 kW, one unit would be needed.

FIGURE 2-4
LUNAR TISEC TURBINE



For the 2 MW Lunar turbine, a minimum depth of 38 m would be required in channels or inlets used by transiting commercial fishing vessels, ferries, most coastal research vessels, recreational motor vessels, and deep-keeled sailing vessels. In passages used by oceangoing commercial vessels, the minimum depth requirement would be 48 m (Hagerman et al. 2005*b*).

The Lunar device is located on a gravity base and the structure remains in place from its weight, and no moorings are required. The unit can be installed in a single operation using a heavy lift vessel, or the main foundation can be pre-installed and a smaller base including the duct and turbine can then be lowered into it. The latter method requires a much smaller lift vessel, though it will take slightly longer to complete the installation. Once the main structure is installed, it remains on the seabed. There are three feet on which the foundation sits, the height of which can be adjusted, to make the unit level (Bedard et al. 2005).

2.3.2 Environmental Issues

From review of available and relevant reports, we identified the issues with the greatest potential for environmental effects at each site.

2.3.2.1 Nova Scotia

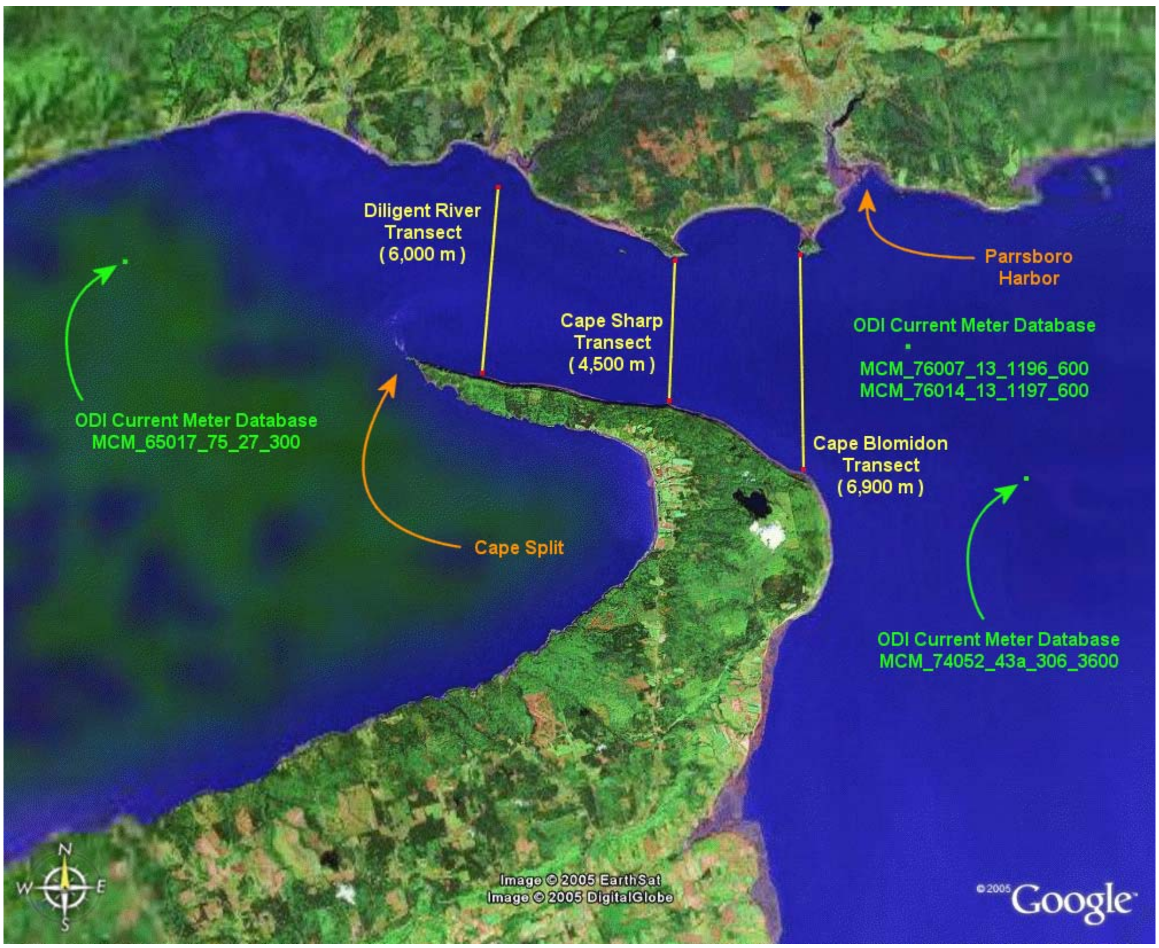
The Minas Passage site was selected for development of the TISEC project in Nova Scotia.

Site Description

Minas Passage connects the rest of Minas Channel and the outer Bay of Fundy to Minas Basin and Cobequid Bay. It is a rectangular body of water that trends northwest-to-southeast, with its outer corner points being Ram Head and Cape Split, and its inner corner points being Cape Blomindon and Parrsboro Harbor (Figure 2-5). The channel-wide average peak current velocity is about six knots (3 m/s). The selected TISEC site is on the Cape Blomindon transect for the pilot project and the Cape Sharp transect for the commercial project (Figure 2-5) (Hagerman et al. 2005*a*).

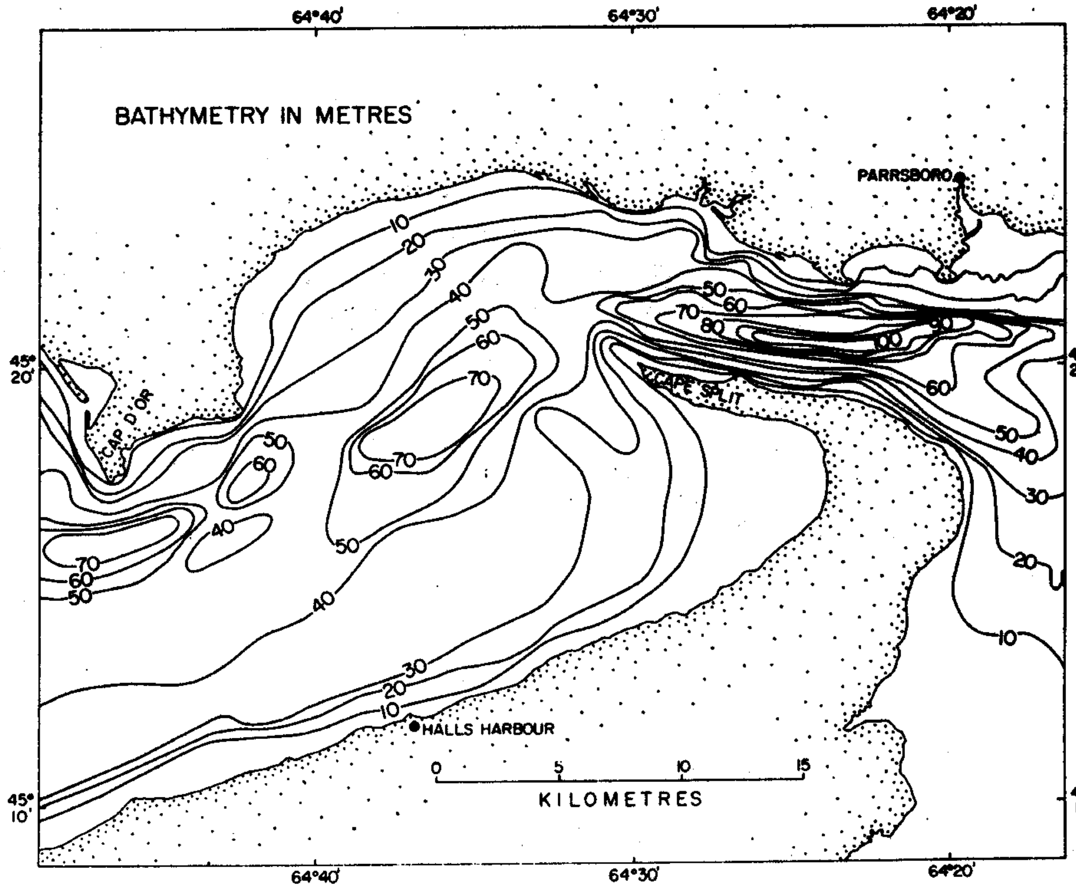
The bathymetry shows a long linear deep depression in the middle of Minas Passage with water depths over 100 m (Figure 2-6) (Hagerman et al. 2005*a*). The average tidal range of Cape Split and in Minas Basin is 13 m (Nova Scotia Museum 2005; Bay of Fundy Ecosystem Partnership 2005). The large tides cause more than 10 cubic kilometers of water, more than 40 times the flow of the St. Lawrence River, to flow by the 5 km gap at Cape Split four times per day (two tidal cycles). The Minas Passage site represented the highest tidal in-stream energy resource in terms of intensity (power density) and magnitude (annual energy flux) of the eight sites analyzed in EPRI's *Nova Scotia Tidal In-Stream Energy Conversion (TISEC): Survey and Characterization of Potential Project Sites* (Hagerman et al. 2005*a*). While water in the area is well mixed, it is not necessarily flushed and dispersed throughout the Bay of Fundy. Rather, floating objects have been seen to float back and forth in Minas Channel over many tidal cycles; the wreckage of a small boat "...drifted there for months before it finally waterlogged and sank" (Bay of Fundy Ecosystem Partnership 2005).

FIGURE 2-5
AERIAL PHOTOGRAPH FROM AN ALTITUDE OF APPROXIMATELY 20 MILES, SHOWING THE CAPE BLOMINDON AND CAPE SHARP TRANSECTS IN MINAS PASSAGE



Source: Google Earth 2005.

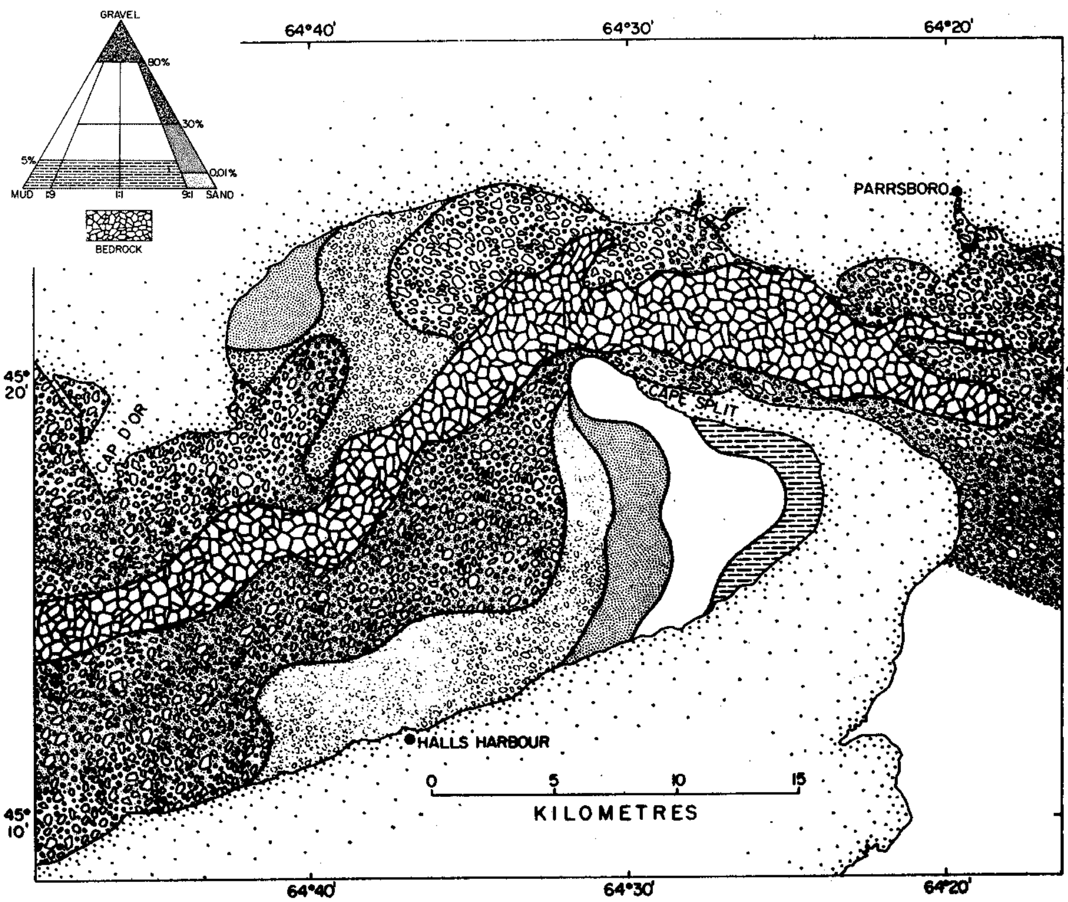
FIGURE 2-6
BATHYMETRIC CONTOUR MAP OF MINAS CHANNEL AND MINAS PASSAGE



Source: Hagerman et al. 2005*a*.

The seafloor of Minas Passage is exposed bedrock, with gravel deposits close to shore on either side (Figure 2-7) (Hagerman et al. 2005*a*). Along the north shore of Minas Passage, muddy sands predominate (pers. comm., Tim Milligan, Department of Fisheries and Oceans Canada [DFO], January 10, 2006). Depths in Minas Passage range from 36 to 110 m (Hagerman et al. 2005*a*). The constriction caused by Cape Split represents a division in the Bay of Fundy. To the east, semi-enclosed Minas Basin is more sheltered and has broad areas of intertidal mud flats; to the west, the Outer Bay of Fundy is more exposed to the Gulf of Maine and is characterized by exposed bedrock and coarse sand and gravel substrate. West of Minas Channel the extreme tidal change in the Bay of Fundy prevents warming of the surface waters in summer, and water temperature never exceeds about 54°F (12°C) (Nova Scotia Museum 2005). Water clarity (secchi depth) in the mouth of the Bay of Fundy is six to 10 m (Bay of Fundy Ecosystem Partnership 2005). East of Minas Channel, surface waters are considerably warmer with water increasing 36°F (20°C) or more after crossing exposed intertidal sand flats (Nova Scotia Museum 2005). Secchi depth is 3 to 4 m in Minas Channel and just a few centimeters in parts of Minas Basin (Bay of Fundy Ecosystem Partnership 2005).

FIGURE 2-7
SEDIMENT AND BEDROCK DISTRIBUTION IN MINAS CHANNEL AND MINAS PASSAGE



Source: Hagerman et al. 2005*a*.

In the Natural History of Nova Scotia, the aquatic community of the Inner Bay of Fundy (IBOF) is described as follows (Nova Scotia Museum 2005):

> *The Inner Bay of Fundy supports large populations of various coastal fish species. Some migrate into the bay for feeding and reproduction, and others are resident in the area throughout the year. Most of the American shad* (Alosa sapidissima) *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,* (Clupea harengus) *alewife* (Alosa pseudoharengus), *blueback herring* (Alosa aestivalis), *American shad, smelt* (Osmerus mordax), *Atlantic tomcod* (Microgadus tomcod), *Atlantic silverside* (Menidia menidia), *windowpane*[10](Scophthalmus aquosus), *smooth and winter flounder* (Pleuronectes putnami and Pseudopleuronectes americanus), *striped bass* (Morone saxatilis), *Atlantic salmon* (Salmo salar), *and American eel* (Anguilla rostrata). *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. ...Various seabirds occur, including gulls and cormorants, as well as various birds of prey (ospreys* (Pandion haliaetus carolinensis) *and bald eagles* (Halieaeetus leucocephalus)*) which use the coastal bluffs and nearby inland areas for nesting. Shorebirds in large numbers visit the mud flats on their passage north in spring and then return late in summer from Arctic breeding areas.*

American shad and Atlantic salmon once represented the two most important fisheries in Minas Basin. Steep declines in the populations of these two species occurred over the first half of the twentieth century. Atlantic salmon in the IBOF are designated as endangered and are further discussed below. In the late 1980s, flounder stocks were overfished and numbers have not fully recovered, resulting in a weakened fishery. The approximately 15 vessels still operating Minas Basin harvest a variety of species including groundfish and lobster (*Homarus americanus*) (Bay of Fundy Ecosystem Partnership 2005).

The Minas Basin includes warm-water invertebrates, remaining from a post glacial period when warmer waters extended along the Gulf of Maine into the Bay of Fundy, are now isolated from main populations in the southern Gulf of Maine or the southern Gulf of St. Lawrence (Nova Scotia Museum 2005; Bay of Fundy Ecosystem Partnership 2005). For example, the truncate borer clam

[10] Windowpane flounder commonly occur in the IBOF, especially as juveniles, where they inhabit tidal channels and mud flats (Nova Scotia Museum 2005).

(*Barnea truncata*, angel wing) is a warm water species found in Minas Basin that occurs nowhere else in Canada (Nova Scotia Museum 2005).

Most cetacean species cover a large range and overwinter in warmer waters, visiting areas around Nova Scotia typically during summer to feed. Small numbers of fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), pilot (*Globicephala melaena*) and northern bottlenose (*Hyperoodon ampullatus*) whales, and harbor porpoises (*Phocoena phocoena*) remain in Nova Scotia waters year round. Species most likely to be found in the Bay of Fundy include humpback, fins, minkes (*Balaenoptera acutorostrata*), and occasionally right whales (*Eubalaena glacialis*). Harbor porpoises are discussed further below (Nova Scotia Museum 2005). Cetaceans are not common in Minas Basin, though small pods of harbor porpoises can be seen and common and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) periodically visit in summer. Larger whales including pilot, minke, and humpback, are rare though occasionally have stranded on the mudflats of Minas Basin (Bay of Fundy Ecosystem Partnership 2005).

Grey seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) occur year round in Nova Scotia waters. Harp and hooded seals (*Phoca groenlandica* and *Cystophora cristata*) are not as common, but are seen seasonally. Ringed seals (*Phoca hispida*) also visit Nova Scotia waters. None of these species breed in the Bay of Fundy or Gulf of Maine, except for harbor seals, which will pup on intertidal mud banks, sandbars, or rock ledges from late April through June (Nova Scotia Museum 2005).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has designated the following aquatic species, which may occur in the project area, as being at risk[11] (DFO 2006*a*):

- Harbor porpoise - special concern
- IBOF Atlantic salmon - endangered
- North Atlantic right whale - endangered

[11] The Atlantic whitefish, Lake Utopia dwarf smelt, and leatherback turtle are also listed but do not occur in the project area. The Atlantic whitefish occurs only in two Atlantic coast drainages of Nova Scotia. The Lake Utopia dwarf smelt is land locked in a New Brunswick lake. The leatherback turtle occurs mostly around the Scotian Shelf and Grand Banks, and periodically in the Gulf of St. Lawrence (DFO 2006).

These species occur not only on the COSEWIC biological status list, but also on the Species at Risk Act (SARA) legal list, for which they have the same designation.

Harbor porpoises are widely distributed over the continental shelves of temperate north Atlantic and Pacific Oceans (DFO 2006*a*). They typically are found in bays, estuaries, and other nearshore waters. Harbor porpoises inhabiting the Bay of Fundy and Gulf of Maine appear to be a discrete population numbering between 50,000 and 90,000 individuals (DFO 2006*a*; NOAA 2006*a*). The highest concentrations in Nova Scotia waters occur in the Bay of Fundy (Nova Scotia Museum 2005). COSEWIC conducted a reassessment of this species in 2003 and down-listed it from threatened to special concern. Bay of Fundy harbor porpoises have been documented to move frequently between Canadian and U.S. waters. Their diet consists of a variety of small fish and cephalopods (DFO 2006*a*). The DFO (2006*a*) reports that part of the diet of harbor porpoises consist of prey living on or near the seafloor, and consequently they are at risk of entanglement in bottom-set gill nets. They are also known to become entangled in herring weirs (Nova Scotia Museum 2005). The DFO (2006*a*) reports that "the most important recent threat to harbor porpoises in eastern Canada is by-catch in bottom-set gill nets used to capture demersal fish species, such as cod...."

The IBOF Atlantic salmon assemblage refers to salmon populations originating in watersheds between the Saint John River in New Brunswick and the Annapolis River in Nova Scotia. This assemblage appears to be further geographically separated with one group returning to rivers in the Minas Basin and the other to the rivers draining into Chignecto Bay and rivers to the west (DFO 2006*a*). The IBOF salmon returning adults were thought to number less than 500 adults in 1999, down from historical averages of approximately 40,000. Declines appear to be related primarily to reduced marine survival (Irvine et al. 2005). Commercial and recreational fishing for Atlantic salmon is now banned (Bay of Fundy Ecosystem Partnership 2005) with harvest in the Bay of Fundy being banned in 1985 for commercial fisheries and in 1990 for recreational fisheries (Irvine et al. 2005). COSEWIC designated IBOF salmon as endangered in 2001 (DFO 2006*a*), and their status is under current review (Irvine et al. 2005).

Right whales congregate in the southern part of the Bay of Fundy to mate, nurse their young, and to feed (Canadian Coast Guard 2006). Because they do not migrate into the upper Bay of Fundy, they would not be of concern at the Minas Passage site.

Potential Effects

Atlantic herring are an important fishery in the Gulf of Maine and the Bay of Fundy. The most productive spawning grounds in the Gulf of Maine is in the outer Bay of Fundy, especially on the southwest of Grand Manan (Bigelow and Schroder 1953). The only spawning grounds for Atlantic herring in the Bay of Fundy proper is centered on Minas Passage (Gulf of Maine Research Institute [GMRI] 2005). However, the amount of spawning that occurs here "...is trifling as compared with the production along the eastern coast of Maine and in the Grand Manan region" (Bigelow and Schroder 1953). Typically, herring spawn over rocky, pebbly, or gravely substrate in depths of 4 to 55 m. The eggs sink sticking in clumps to the bottom (Bigelow and Schroder 1953). It is expected that a TISEC turbine would not negatively affect drifting eggs and that schools of spawning or migrating herring would avoid project turbines, much as they would avoid a large approaching fish or marine mammal.

Because of its location at the mouth of Minas Basin, the project will be located within the migration corridor of IBOF Atlantic salmon, an endangered species. Consequently, potential effects of the tidal project on migrating Atlantic salmon will be of concern. As discussed with herring, it is expected that because of the open nature and slower operating speed of a TISEC turbine, as opposed to a conventional hydro turbine or a boat propeller, combined with the fact that Atlantic salmon and many other marine organisms have high perceptive powers and agility, giving them the ability to avoid collisions, TISEC turbines are expected to have minimal effects on salmon and other marine life. However, without any studies having yet been completed regarding potential injury to herring, salmon, or other marine life resulting from turbine strikes or the potential disruption of migration routes, this has not yet been confirmed. Installing fish screens on turbines is not preferred as it can potentially decrease or interfere with flow characteristics and increase turbine maintenance due to biofouling and clogging.

Scallop dragging is precluded in the deep and fast currents of Minas Passage (Hagerman et al. 2005*a*). Lobsters are "...concentrated in the deeper areas of the Minas Channel, where strong currents sweep the gravelly bottom free of silt. Only very large, heavy traps weighed down with hundreds of pounds of concrete can be set in such currents, requiring the use of larger boats than are normally used for lobstering" (Bay of Fundy Ecosystem Partnership 2005). Both MCT Seagen and

Verdant turbines are suspended off the seabed, and as such should not pose a risk to entraining lobsters or other marine life that crawl along the bottom. The foundations of the units would occupy a relatively small area of seabed habitat and lobsters could readily migrate around the project's base (pers. comm. David Robichaud, DFO, December 22, 2005).

In initial discussion with DFO biologists, the main concern with regard to project effects on marine mammals was whether the TISEC units make excessive noise. There is evidence that boat engine noise can result in disturbance of marine mammals. If the turbines are fairly quiet, it is thought that this would not be an issue (pers. comm., Lei Harris, DFO, January 6, 2006). Underwater noise for the proposed units has not been quantified, but it is expected to be relatively low because of the low speed of operation, especially in comparison to a boat propeller, and the need to minimize cavitation (Bedard et al 2005). DFO biologists did not expect that the turbine would directly harm marine mammals because they would be able to see and hear the device and swim around the unit (pers. comm., Lei Harris, DFO, January 6, 2006).

While some marine mammals may become entangled in fishing gear (e.g., harbor porpoises in gill nets; right whales in lobster pot lines), entanglement is not expected to be an issue at a TISEC project because no gear is associated with the project that would risk entanglement of passing sea life. If buoys are required to mark the TISEC project, the risk of entanglement may need to be considered. DFO will need to be consulted during permitting of the project regarding potential project effects on threatened and endangered species.

Most seabird nesting sites occur on the Atlantic coast of Nova Scotia. There are few suitable sites along the Bay of Fundy coast, and seabirds are not abundant in this area (Nova Scotia Museum 2005). However, double-crested cormorants (*Phalacrocorax auritus*), herring gulls (*Larus argentatus*), and great black-backed gulls (*L. marinus*) do nest on islands in Minas Basin and waterfowl and shorebirds are abundant in Minas Basin (Bay of Fundy Ecosystem Partnership 2005). Waterfowl and shorebirds frequent the tidal flats and estuaries of Minas Basin to the east of the project area. Also, muddy sands occur along the north shore of Minas Passage (pers. comm. Tim Milligan, DFO, January 10, 2006) and would likely also be frequented by shorebirds. The project location in Minas Passage is not expected to result in any effects to seabirds, waterfowl, or shorebirds.

Because of the extreme turbulence of tides funneling through Minas Passage, the water column in the Bay of Fundy is well mixed and temperature and salinity stratification does not occur (Bay of Fundy Ecosystem Partnership 2005). TISEC turbines therefore would not affect water temperature or salinity in the water column. Because of the tremendous tides flowing in and out of Minas Basin, coarse material (sand) is suspended in the water column with deposition of up to 100 mg/L occurring (pers. comm. Tim Milligan, DFO, January 10, 2006). The resulting abrasive effects on turbine components represent an effect not shared at other sites.

Because of the tremendous current that courses through Minas Passage four times per day, neither the prototype nor the commercial scale project is expected to modify the currents or result in changes to siltation patterns. The high-energy environment has resulted in little or no accumulation of fine sediment in the main passage. The seabed is well armored by the bedrock and gravel, and the area will be resistant to scour. Likewise, the effects to the area benthos should also be minimal. For the same reasons, scouring should be negligible along the underwater transmission cable. However, the north shore of Minas Passage, where the transmission cable would come ashore, is characterized by a muddy sand bottom. This indicates the presence of fine sediments near shore. Open trenching may be appropriate in this area in order to bury the underwater transmission cable; if concerns are raised regarding effects to these habitats, HDD may be appropriate.

Because of the hard substrates in the area, the transmission cable will likely be anchored to the sea bed. A fishing and anchor exclusion area will consequently be required along the project transmission cable route to prevent damage to ships, their equipment, and the project. The size of the exclusion zone is not known at this time.

Sea ice occurs in the upper part of the Bay of Fundy from December to April, and shifting sea ice is a significant winter feature off of Cape Split (Nova Scotia Museum 2005). From January through March, easterly and northerly winds blowing for several days, in combination with ebb tides, result in ice floes flushing from Minas Basin and Chignecto Bay to the north. During the extreme cold of 1968, Minas Channel, Passage, and Basin and much of the upper Bay of Fundy were covered by an enormous ice field (Atlantic Tidal Power 1969). This may preclude access to TISEC units seasonally. Effects of shifting ice will need to be considered on the underwater transmission cable near shore. Shore-fast ice, which grows to its greatest thicknesses in areas of rock ledges exposed at low tides and in areas of steep gradients (Atlantic Tidal Power 1969), could result in damage to the underwater transmission cable. If stress to the underwater transmission cable is severe, burying the cable may be necessary to protect it.

The EPRI team is considering the MCT Seagen or Verdant units for this site. As discussed above, for the 16 m rotor diameter of MCT's 1.2 MW Seagen device, the required depth range to install this type of device would be 20 to 30 m (MCT 2005). Because the depths of the identified site are 36 to 110 m (Hagerman et al. 2005*a*), an MCT Seagen device would have to be located nearer shore where the depths are less. As mentioned above, the seabed in Minas Passage proper consists of exposed bedrock with gravel deposits close to shore. Because of this hard substrate the anchoring of work barges and associated equipment for deployment of either MCT Seagen or Verdant turbines will represent, at most, only minor and temporary effects to the seabed.

While the specific location of the site within Minas Passage has not yet been determined, the channel center is about 2 to 3 km from the northern shore. An underwater transmission cable would be run along the bottom of the channel over this approximate distance to transmit the generated power to a shore station. Because there are no fine sediments in the main part of the channel, deployment of the underwater transmission cable will not result in sediment re-suspension and scour will not occur during operation of the project. The sand occurring along the north shoreline may be more susceptible to disturbance during deployment of the transmission cable.

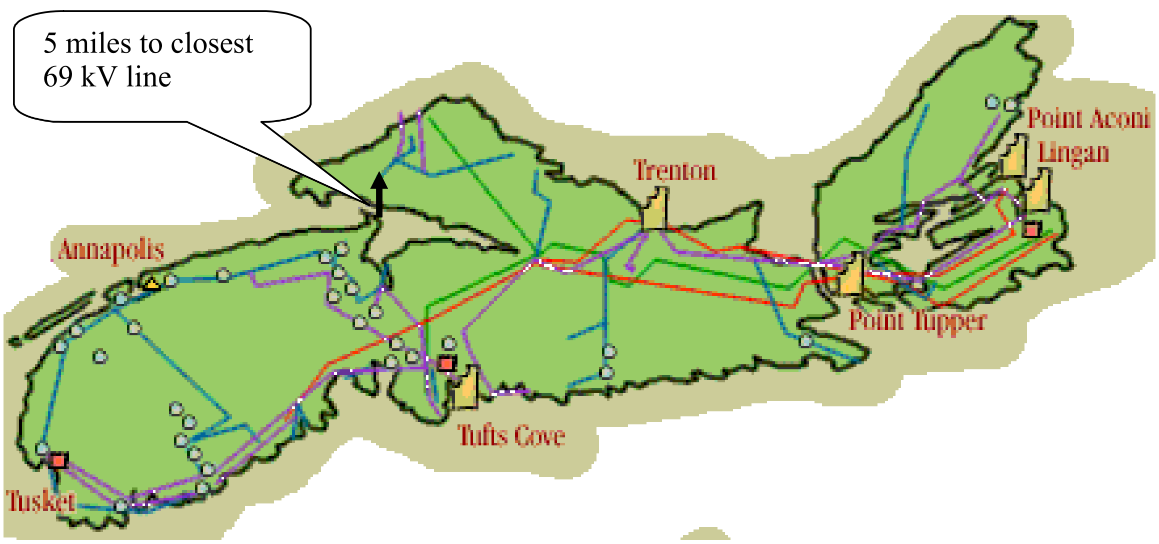
For a 500 kW demonstration TISEC plant, an overhead transmission cable would be constructed about 10 km from the shore to the nearest interconnection to a 25 kV transmission line, which is located in Parrsboro on the north shore of Minas Passage (Figure 2-8). For a commercial 10 MW TISEC plant, approximately 13 km of transmission line would be constructed to the nearest interconnection to a 69 kV transmission line (Figure 2-9) (Hagerman et al. 2005*a*). The area that would be crossed by the transmission line is rural in nature and appears to be a mix of forested and agricultural land.

Tourism and eco-tourism are a growing industry in the region. Cape Blomindon Provincial Park is located at the base of Cape Split and there is a popular trail along Cape Split. Sea kayaking is also a popular activity. Both Verdant and MCT Seagen tidal unit/s and underwater transmission cable will be obscured from view. The shore station can be built so as to minimize aesthetic effects.

FIGURE 2-8
DISTANCE FROM SITE TO CLOSEST GRID CONNECTION

Source: Hagerman et al. 2005*a*.

FIGURE 2-9
DISTANCE FROM SITE TO CLOSEST 69 KV CONNECTION



Source: Hagerman et al. 2005*a*.

The proposed project should have negligible effects on the aesthetics of the area. Anchoring and commercial fishing will likely be precluded in the turbine field area regardless of turbine type.

2.3.2.2 New Brunswick

The Head Harbor Passage site was selected for development of the TISEC project in New Brunswick.

Site Description

Head Harbor Passage trends southwest to northeast from Friar Roads and is the main shipping entrance channel to Passamaquoddy Bay and Cobscook Bay from the adjacent Bay of Fundy. The northwest shore of Campobello Island and the entrance to Harbor de Lute form the southeastern side of Head Harbor Passage. Its northwestern side is formed by a series of islands, rocks and shallow shoals that similarly trend southwest to northeast (Figure 2-10) (Hagerman et al. 2005*b*).

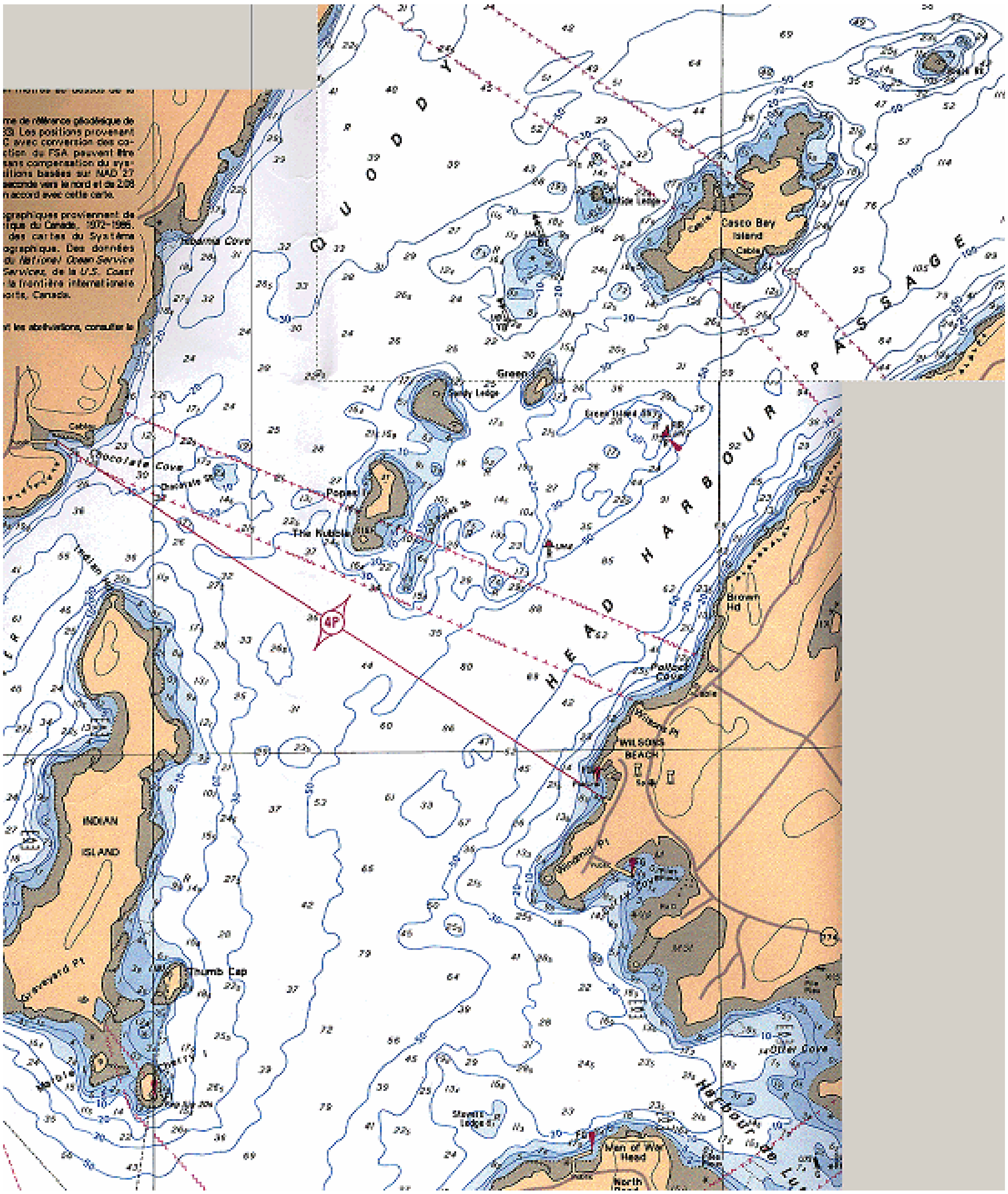
A bathymetric contour chart of Head Harbor Passage is given below (Figure 2-11). This site is characterized by deep water (60 to 100 m) and fast current. Tidal current velocities average about 2.6 m/s (5 knots) (Hagerman et al. 2005*b*). The principal navigation entrance to Passamaquoddy Bay is around the northern end of Campobello Island through Head Harbor Passage.

The Head Harbor Passage area consists of bedrock overlain by poorly-sorted till directly deposited from advancing and retreating glaciers during the last glaciation. These hard, boulder sediments are overlain by glaciomarine sediments, which in turn are overlain by sandy sediments reworked by rising and falling sea level. In sheltered and deeper areas of lower current velocities, these regressive and transgressive sand and gravel sequences may be undisturbed, but in high-current channels, such as where the TISEC project will be located, mud and fine sand are winnowed away, leaving a thin armoring layer of gravels, cobbles, and boulders (Hagerman et al. 2005*b*).

FIGURE 2-10
GEOGRAPHIC LANDMARKS FOR HEAD HARBOR PASSAGE

Source: Hagerman et al. 2005*b*.

FIGURE 2-11
SCANNED SECTION OF CHS CHART #4114 FOR HEAD HARBOR PASSAGE
(*Depths are in meters, with dark blue bathymetric contours as indicated*.)



The mouth of the Bay of Fundy is very important for commercial fishing aquaculture, shipping, and tourism. In describing the area, the Canadian Coast Guard (2006) stated:

> *The Bay of Fundy is the fishing grounds for Canada's second largest commercial fishing fleet and, in addition to this historical form of fishery, the shore based fish farming or 'aquaculture' in the area of Grand Manan, Passamaquoddy Bay and Deer Island contributes an additional $150 million plus to the area's economy each year. Tourism is a growing industry with 'the world's largest tides', whales, and coastal scenery being the major attractions for visitors from all over the globe.*

The main fisheries in the area are for lobster, herring, and sea urchins (pers. comm. Blythe Chang, DFO, December 22, 2005; Nova Scotia Museum 2005). Many of Nova Scotia's herring overwinter off the Atlantic coast of the province (Chedabucto Bay) and, during summer, move to areas off southwest Nova Scotia and the mouth of the Bay of Fundy to feed and spawn. A major tidal front occurs here resulting in mixing of nutrient-rich water and an increase in water column productivity (Nova Scotia Museum 2005). The Passamaquoddy Bay-Grand Manan region represents the area of the Gulf of Maine where herring are most abundant having historical landings four times as great as for the Maine coast as a whole and 13 times as great as for the Massachusetts coast (Bigelow and Schroder 1953). However, coastal schools of juvenile herring have become vastly diminished in recent years. Today, the fixed-gear weir fishery for herring exists primarily along Grand Manan Island and New Brunswick's Bay of Fundy coast. No Atlantic herring spawning grounds are found in the Passamaquoddy Bay area, including the proposed project site (GMRI 2005).

Other important fish species (Atlantic cod [*Gadus morhua*], haddock [*Melanogrammus aeglefinus*], pollock [*Pollachius virens*], silver hake [*Merluccius bilinearis*], American plaice [*Hippoglossoides platessoides*], and redfish (*Sebastes sp.*]) spawn primarily in the Atlantic on offshore banks or over the continental shelf. Red hake (*Urophycis chuss*) migrate from the Gulf of Maine into Passamaquoddy Bay. Witch flounder (*Glyptocephalus cynoglossus*) and Atlantic halibut (*Hippoglossus hippoglossus)* also are locally abundant (Nova Scotia Museum 2005).

Although marine mammals are seen in this area, they do not usually occur in great numbers in Head Harbour Passage (pers. comm. Lei Harris, DFO, January 6, 2006). Fin, minke, and occasionally humpback whales reside locally in the area in summer months (pers. comm. David Robichaud and Lei Harris, DFO, December 22, 2005). Harbor porpoises also inhabit the area.

COSEWIC has designated the following aquatic species, which may occur in the project area, as being at risk (DFO 2006*a*):

- Harbor porpoise - special concern
- North Atlantic right whale - endangered

Right whales have a population of only about 300 in the North Atlantic and are endangered in Canada (Lien 2005). "The Outer Bay of Fundy has been recognized as a feeding ground for right whales during the summer and autumn. The vicinity of Grand Manan Island is visited by a population of about 200 Northern Right Whales in summer, and they can be observed in Head Harbor Passage, Grand Manan Channel, and along the edges of Grand Manan Basin" (Nova Scotia Museum 2005). Right whales come to the southern part of the Bay of Fundy to mate, nurse their young, and to feed (Canadian Coast Guard 2006). The outer Bay of Fundy is considered one of the five key habitat areas for right whales (NMFS 2005), and a right whale sanctuary has been designated off Grand Manan (Lien 2005). Collisions with passing ships and entanglement in fishing gear represents the greatest causes of mortality to right whales (Canadian Coast Guard 2006). Life history and regional information for harbor porpoise is discussed above in Section 2.3.2.1. Salmon farms are found in coves and bays along the west and northwest coastline of Campobello Island (Hagerman et al. 2005*b*; pers. comm. New Brunswick Advisory Group, March 16, 2006).

Potential Effects

The most important potential environmental issues for Head Harbor Passage is interference with navigation and commercial fishing and effects on marine mammals (pers. comm. Kim Hughs, NB Dept of Environment and Local Government, December 20, 2005 and Karen Coombs, NB Dept. of Agriculture Fisheries and Aquaculture, December 21, 2005). Effects of the project on migrating wild Atlantic salmon and herring would also be of concern (pers. comm. Blythe Chang, DFO, December 22, 2005).

Lunar RTT and MCT Seagen devices are being considered for the Head Harbor Passage site. For the 2 MW Lunar RTT turbine, a minimum depth of 38 m would be required in channels or inlets used by transiting commercial fishing vessels, ferries, most coastal research vessels, recreational motor vessels, and deep-keeled sailing vessels. In passages used by oceangoing commercial vessels, such as Head Harbor Passage, the minimum depth requirement would be 48 m (Hagerman et al. 2005*b*).

Considering that the Head Harbor Passage is 60 to 100 m deep, there should be adequate clearance for navigation of commercial ships, over the project site if the Lunar RTT or MCT turbine is installed. Depending on the exact siting of the project in Head Harbor Passage, maintenance or other activities requiring access to the TISEC project may be disrupted when commercial ships pass through Head Harbor Passage.

Because there are no fine sediments at this site, project construction is not expected to result in sediment re-suspension and scour will not occur during operation of the project. The hard substrates at this site will likely result in construction effects to the seafloor, if any, being minor and temporary.

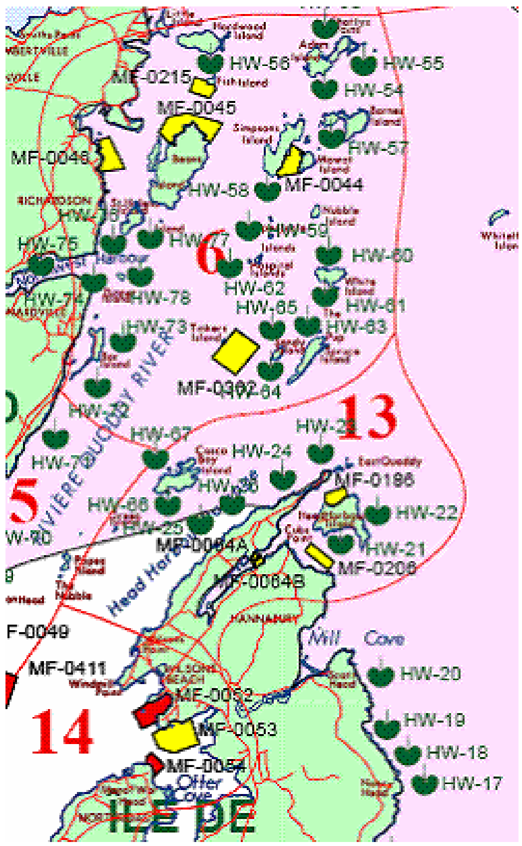
Lobsters migrate along the ocean bottom throughout the year. The presence of a single Lunar RTT unit (prototype phase) is not expected to affect the lobster population in that it would occupy a relatively small area of seabed habitat and lobsters could readily migrate around the project's base (pers. comm. David Robichaud, DFO, December 22, 2005). However, it is not known to what extent lobsters migrating upstream of a Lunar RTT turbine would be affected by the plant's operation, i.e., would lobsters be drawn into the turbine. Lobster fishing occurs mostly along the shore of Head Harbor Passage and, due to the depth and fast current, are not set in the middle of the passage (pers. comm. David Robichaud, DFO, December 22, 2005) where the Lunar RTT turbine would be deployed.

MCT Seagen rotors are held off the bottom, likely by a monopile structure. Consequently, neither the presence of the monopile foundations nor the operation of MCT Seagen units are expected to negatively affect lobsters.

While there are a number of herring weirs in the general area (Figure 2-12), they are not located in the main channel of the Head Harbor Passage, which is 60 to 100 m deep and has very fast currents.

Whether the project would affect recreational fishing or migratory routes of herring, Atlantic salmon, or marine mammals, was raised as a likely concern (pers. comm, Karen Coombs, New Brunswick Department of Agriculture Fisheries and Aquaculture, December 21, 2005; pers. comm. Blythe Chang, DFO, December 22, 2005).

FIGURE 2-12
HERRING WEIRS LOCATED IN HEAD HARBOR PASSAGE AND VICINITY



Source: pers. comm. Russell Henry, NB Dept. of Agriculture Fisheries and Aquaculture, December 20, 2005.

As discussed above for the Nova Scotia site, from initial discussion with DFO biologists, the main concern with regard to marine mammals was whether the TISEC units make excessive noise. There is evidence that boat engine noise can result in disturbance of marine mammals. If the turbines are fairly quiet, it is thought that this would not be an issue (pers. comm., Lei Harris, DFO, January 6, 2006). Underwater noise is expected to be relatively low because of the low speed of operation, especially in comparison to a boat propeller, and the need to minimize cavitation (Bedard et al. 2005). DFO biologists did not expect that the turbine would directly harm marine mammals because they would be able to see and hear the device and swim around the unit. DFO biologists noted that Head Harbor passage is not an area where whale concentration is high in this region; from initial and preliminary review of the project, the risks to marine mammals of this project are expected to be negligible, unless noise is determined to be an issue (pers. comm., Lei Harris, DFO, January 6, 2006).

As previously mentioned, it is expected that because of the open nature and slower operating speed of a TISEC turbine, as opposed to a conventional hydro turbine or a boat propeller, combined with the fact that Atlantic salmon and many other marine organisms have high perceptive powers and agility, giving them the ability to avoid collisions, TISEC turbines should have minimal effects on fish and other marine life. However, without any studies having yet been completed, this has not yet been confirmed. As mentioned in Section 2.3.2.1, it is not preferable to equip the TISEC turbines discussed in this report with fish screens. DFO should be consulted regarding potential project effects on threatened and endangered species.

Some fishermen are permitted to fish for groundfish using bottom nets which are anchored to the bottom. The deployment of these nets is not publicized, and determining whether the project would affect these nets would need to be considered as the project proceeds.

A potential conflict to the salmon farms located in the coves and bays along the northwest coastline of Campobello Island would arise if excessive amounts of tidal current energy were withdrawn from this channel, reducing the natural flushing action through salmon-rearing pens. No studies have been conducted to determine the amount of tidal energy that can be extracted from a tidal stream without adversely affecting the local aquatic community. For the purposes of this project, EPRI determined that the commercial scale plants will be designed so as to extract less than 15 percent of the tidal energy of a selected site (Hagerman et al. 2005*b*).

The hydraulic oils in the Lunar RTT turbine are environmentally benign. MCT Seagen turbines contain only small quantities of lubricating oil or other potential pollutants, which are well contained and unlikely to escape. Lunar and MCT indicate that they will ensure that any antifouling coating of the blades and any other components (the duct for Lunar devices), if required, will reflect current best practices (Bedard et al. 2005).

There is a submarine power cable crossing from the western shore of Head Harbor, mid-way along the road between Wilson's Beach and East Quoddy Head, to Casco Bay Island, and then from Casco Bay Island to Leonardville on Deer Island. Leonardville is then connected to the New Brunswick mainland by an overhead power line that crosses Letete Passage (Hagerman et al. 2005*b*)[12].

Because of the hard substrates in the area, the transmission cable will likely be anchored to the sea bed. A fishing and anchor exclusion area will consequently be required along the project transmission cable route to prevent damage to ships, fishing equipment, and the project.

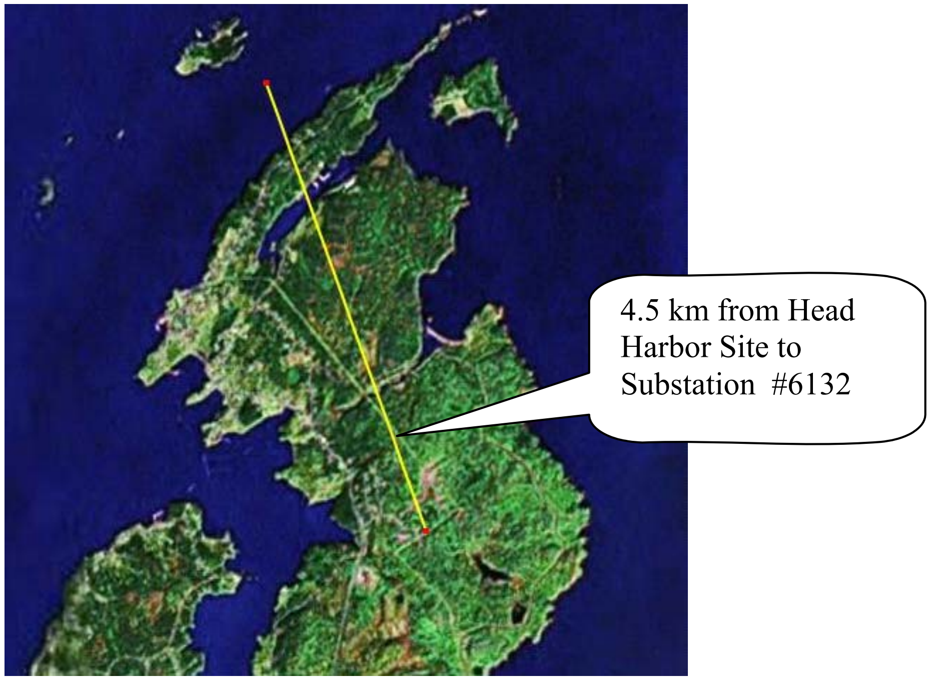
Head Harbor Passage is served by New Brunswick Power Company (NB Power). NB Power recommended transmitting project power to the Campobello substation No. 6132 (Figure 2-13). The distance to a 12.5 kV transmission line, which would be used for a 0.5 to 1.0 MW prototype plant, has not yet been determined; the distance to a 69.5 kV transmission line, which would be used for a 5 to 10 MW commercial plant, is 4.5 km (Hagerman et al. 2005*b*). This general area is rural and appears to be primarily forested. With regard to the terrestrial transmission line component of this project location, it is possible that visual effects of the overhead transmission line may be of concern considering the importance of viewsheds and tourism to Campobello Island.

2.3.2.3 Maine

The Western Passage site in Eastport was selected for development of the TISEC site in Maine. The site is located along the transect between Dog Island and Deer Island, on the U.S. side of the boundary with New Brunswick.

12 The submarine cable crossing of Head Harbor Passage at Casco Island represents an opportunity for a potential tidal in-stream power project there to share this underwater cable corridor and associated shore-crossing easement (Hagerman et al. 2005*b*).

FIGURE 2-13
DISTANCE FROM SITE TO 69/12.47 KV ON CAMPOBELLO ISLAND, THE CLOSEST CONNECTION



Source: Hagerman et al. 2005*b*.

Site Description

Western Passage cuts between Moose Island on the U.S. side and Deer Island, the next large Canadian island northwest of Campobello Island, and connects Friar Roads with Passamaquoddy Bay (Figure 2-14). It is entered between Deer Island Point, which is at the south end of Deer Island, and Dog Island, which lies off the east side of Moose Island. Western Passage is the western conduit for waters from the Cobscook Bay, St. Croix River, and Passamaquoddy Bay (Hagerman and Bedard 2005*a*). As such, it is known for its strong currents and eddies, including "Old Sow," the largest tidal whirlpool in the Western Hemisphere[13].

The hydrodynamic driving force behind the Old Sow is the conjunction of two tidal currents that meet at a right angle off Deer Island Point. The turbulence generated by the collision of these two currents is enhanced by the plunging bottom profile south of Deer Point, which deepens from 120 to 300 feet at a slope of more than 45 degrees (Hagerman and Bedard 2005*a*). The whirlpool is most active during flood current, two to three hours before high water, when the vortex can attain a diameter of up to 250 feet and a depth of up to 40 feet (Old Sow Whirlpool 2005). It is less pronounced during ebb flows (Hagerman and Bedard 2005*a*).

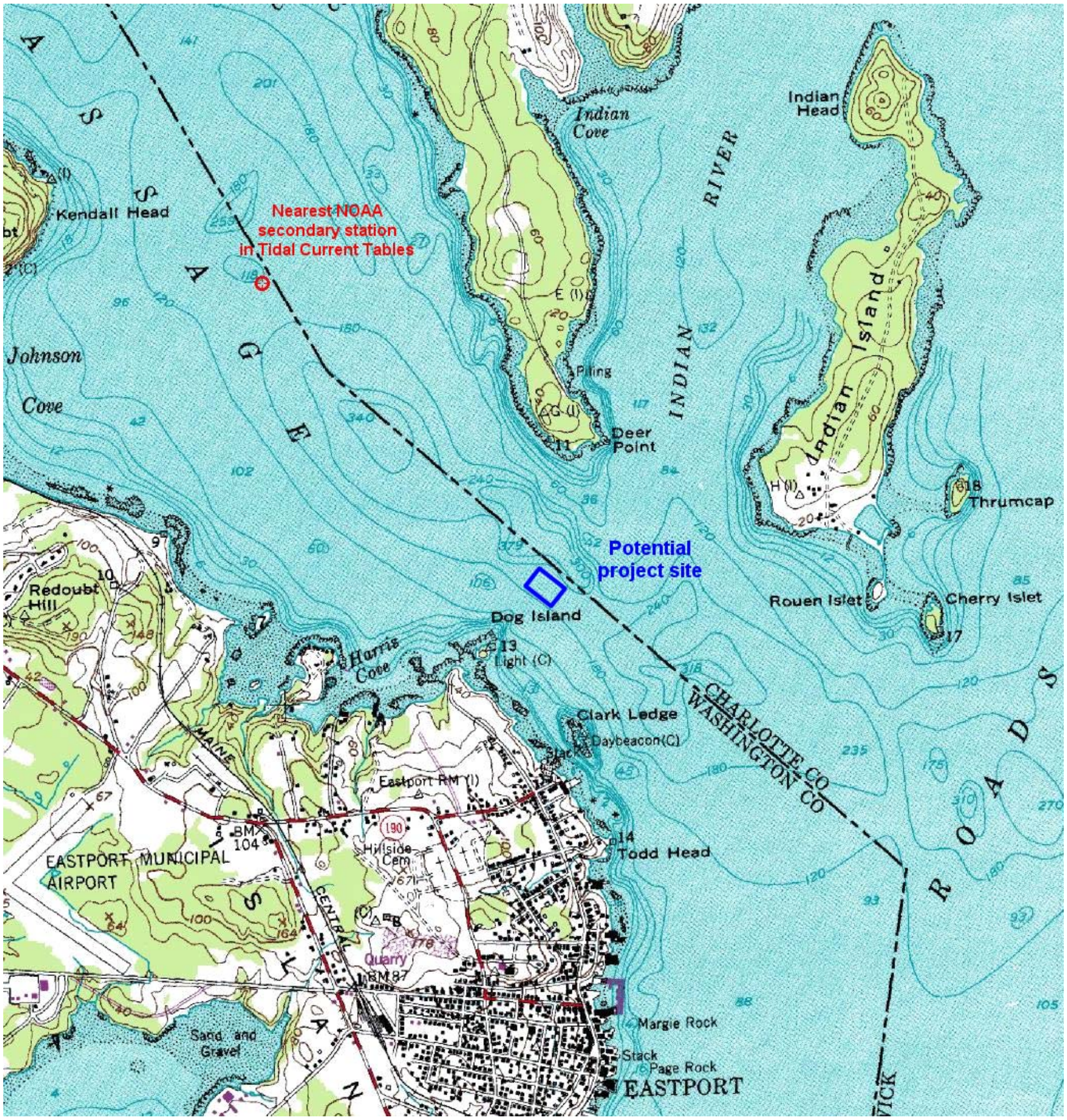
Maps of bathymetric contours (Figure 2-15) and geology, characterizing the surface properties of the seafloor in the northern part of Lubec Narrows and Friar Roads (Figure 2-16), are given below. The Western Passage varies in depth from 55 to 73 m (180 to 240 feet) and the bottom consists of gravel/mud, rock, and rock/gravel. The bathymetric map presented later in this section shows this least turbulent location to lie along the 55 m depth contour, where tidal in-stream devices could be installed with ample navigation clearance even for deep-draft vessels (Hagerman and Bedard 2005*a*).

FIGURE 2-14
LOCATION MAP FOR WESTERN PASSAGE SITE (GOOGLE EARTH)

Source: Google Earth (Hagerman and Bedard 2005*a*).

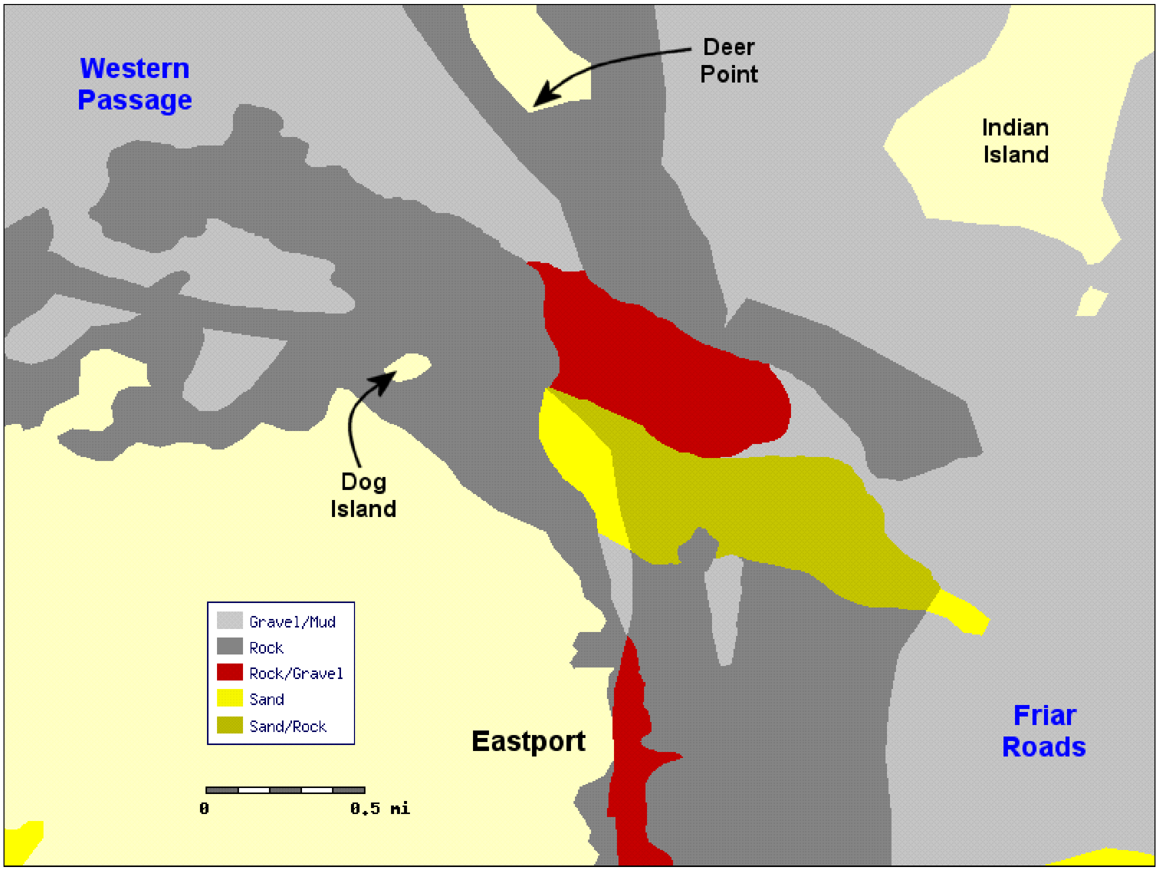
[13] The Old Sow is one of five significant whirlpools worldwide; the others being in Scotland, Norway, and Japan. It vies with the one of the Norwegian whirlpools for title of the world's most powerful whirlpool, with both having vortex current speeds up to 15 knots (Wikepedia 2005).

FIGURE 2-15
BATHYMETRIC CHART OF WESTERN PASSAGE



Note: A proposed site for a tidal in-stream energy project is indicated by the blue rectangle between the 180- and 240-foot-depth contours just northeast of Dog Island. Source: AcmeMapper (Hagerman and Bedard 2005*a*).

FIGURE 2-16
SURFICIAL GEOLOGY OF WESTERN PASSAGE (REFERENCE 8)



Source: Maine Coastal Surficial Geology (Hagerman and Bedard 2005*a*).

In describing the adjacent Cobscook Bay, the Maine Natural Areas Program ([MNAP] 2005) characterizes the marine community that occurs in the area:

> *Cobscook Bay's tremendous tides circulate nutrient rich water from the deeper waters of the Gulf of Maine. Higher concentrations of nutrients in the tidal water stimulate increased plant growth, such as prolific blooms of phytoplankton, which in turn foster a variety of invertebrate species such as bottom dwelling shellfish, marine worms, and other important invertebrates. The abundance of marine animals leads to a high amount of biological waste production, which is then recycled into an added source of nutrients for plant growth. This internal process is a key part of what makes Cobscook Bay so productive. Cobscook Bay is an outstanding resource for marine invertebrates and fish species, which contributes to its important role as habitat for a variety of bird species.*

A number of species of marine invertebrates in Cobscook Bay and the eastern Gulf of Maine exhibit giantism, with species of starfish, brittlestars, tunicates, sea urchins, and periwinkles reaching unusually large size (Larsen 2005). Species of commercial importance that occupy the area include lobsters, scallops, and sea urchins. Scallops and sea urchins are typically captured by dragging while lobsters are caught in pots. There is substantial use of the area by commercial fishermen for these species, though fishing does not typically occur in the main part of Western Passage, where the project is proposed to be sited, because of the fast currents. The season for each fishery is as follows: 1) lobster - April to November; 2) scallops - December to April; and 3) sea urchins - October to March (pers. comm., D. Etnier, Maine Department of Marine Resources [MDMR], August 16, 2005; pers. comm., Lt. Alan Talbot, Maine Marine Patrol, December 16, 2005). Salmon farms are found along the shores of Western Passage(Hagerman and Bedard 2005*a*).

The Western Passage site is located less than 10 km from the Head Harbor Passage site in New Brunswick, located on the other side of Deer and Indian Islands, and consequently, the marine community is very similar to that described above in Section 2.3.2.2. Atlantic herring represent an economically important and numerous fish in the Gulf of Maine. It is consumed by humans, is used for lobster bait, and is an important species linking plankton and the many species that prey on herring (GMRI 2005). Bigelow and Schroeder (1953) report that the tremendous (historic) abundance of young herring in the Passamaquoddy region results from the fact that, like the planktonic animals on which they feed (i.e., euphausiid shrimps (*Thysanoessa spinifera*) and copepods), they swim and drift with the current. Because of the circulation of shallow and deeper water layers, which results from the interaction of fresh water inflow and currents, large numbers of the young herring end up in the Passamaquoddy region (Bigelow and Schroeder 1953). No Atlantic herring spawning grounds are found in the Passamaquoddy Bay area, including the proposed project site (GMRI 2005).

The sardine fishery was a major industry in coastal Maine and the Gulf of Maine region through the mid 1900s. As previously mentioned, today, coastal schools of juvenile herring have become vastly diminished though the herring fishery still supports a cannery business, which is valued at $40 million per year in Maine. Area towns, including Eastport and Lubec, have focused on other industries such as lobster harvest and aquaculture (GMRI 2005).

MNAP (2005) reports that thousands of shorebirds stop in Cobscook Bay during fall on their migration south from northern breeding sites, "...attracted by excellent foraging and roosting habitat. The irregular shoreline and strong tidal flow keeps the Bay relatively free of winter ice and makes it a very attractive area for waterfowl such as black ducks (*Anas rubripes*) and Canada geese (*Branta Canadensis*) throughout the year. In certain years, as much as 25 percent of the state's wintering black duck population may be found in Cobscook Bay."

U.S. and Maine-listed threatened and endangered species that may occur in the project area are listed in Table 2-1

TABLE 2-1
THREATENED AND ENDANGERED SPECIES THAT MAY OCCUR IN THE WESTERN PASSAGE PROJECT AREA

Species	Status	Habitat in Maine	Record Locations In Proximity To Project Area	Probability of Occurrence	Notes
Atlantic salmon *Salmo salar*	Federally Endangered	Listed for 8 rivers in eastern Maine	Spawning and rearing in Dennys River; feeding and migration through Gulf of Maine	Likely	One of the 8 river, the Dennys River, empties into the adjacent Cobscook Bay
Bald eagle *Halieaeetus leucocephalus*	State Threatened Federally Threatened	Nesting, feeding, wintering throughout the state	Nesting, feeding, wintering in Cobscook Bay	Likely	Highest concentration of breeding bald eagles in Maine nest in Cobscook Bay.
Northern right whale *Eubalaena glacialis*	Federally Endangered	Summer feeding, courtship	Bay of Fundy	Likely	Outer Bay of Fundy important feeding ground. Right whale sanctuary designated off Grand Manan (NB)
Humpback whale *Megaptera novaeangliae*	Federally Endangered	Summer feeding	None; occasionally inhabit waters close to shore	Likely	Primarily inhabit Continental Shelf waters
Fin whale *Balaenoptera physalus*	Federally Endangered	Summer feeding	None	Unlikely	Most typically observed deep waters over Continental Shelf
Loggerhead *Caretta caretta*	State Threatened Federally Threatened	Feeding: in inshore and pelagic waters	None	Rare	Range northward in summer as far as Newfoundland. Gulf of Maine sightings are rare
Leatherback *Dermochelys coriacea*	Federally Endangered	Feeding: pelagic waters	None; occasionally enter shallow waters in bays and estuaries	Unlikely	Frequent feeders in outer Gulf of Maine in deep waters (200 feet)

On November 13, 2000, NMFS and the U.S. Fish and Wildlife Service (USFWS) announced Atlantic salmon populations in eight Maine rivers (Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap and Sheepscot rivers, and Cove Brook) were officially declared endangered. The Dennys River empties into the western portion of Cobscook Bay, which is located adjacent to Western Passage. In 2004, only one salmon was captured at the monitoring weir, located in the Dennys River at the head of tide. The Maine Atlantic Salmon Commission (MASC) reported that this was "...exceedingly low given the fact that approximately 50,000 smolts ... are stocked each year in the Dennys River" (MASC 2004).

MNAP (2005) reports that the Cobscook Bay area has the highest concentration of nesting bald eagle pairs in the state and that this area was important to the successful restoration of eagle populations in Maine and the northeast U.S. Unlike other areas of the Maine coast, alewives represent a major component of the bald eagle's diet.

As with nearby Head Harbor Passage (pers. comm. Lei Harris, DFO, January 6, 2006), it is expected that high concentrations of whales do not occur in Western Passage. Fin, minke, and occasionally humpback whales are known to reside locally in the area in summer months (pers. comm. David Robichaud and Lei Harris, DFO, December 22, 2005). Harbor porpoises also inhabit the area. As discussed previously, the right whale population numbers only about 300 in North Atlantic and are endangered in Canada (Lien 2005), and the vicinity of Grand Manan Island is visited by a population of about 200 Northern Right Whales in summer. They have been observed in Head Harbor Passage, Grand Manan Channel, and along the edges of Grand Manan Basin (Nova Scotia Museum 2005). In its range, collisions with passing ships and entanglement in fishing gear represent the greatest causes of mortality to right whales (Canadian Coast Guard 2006).

In the northeastern U.S., NMFS works with the New England Fishery Management Council and the Mid-Atlantic Fishery Management Council to define essential habitat for important species in New England waters. EFH is mapped in 10-by-10-minute squares. In the project area, NMFS has identified EFH for a number of species and lifestages in the 10-by-10-minute square area that includes the proposed project site (Table 2-2).

TABLE 2-2
FISH SPECIES/LIFESTAGES FOR WHICH EFH DESIGNATED IN A 10-BY-10 MINUTE SQUARE AREA THAT INCLUDES THE PROPOSED WESTERN PASSAGE TISEC SITE

Species	Eggs	Larvae	Juveniles	Adults
Atlantic salmon (*salmo salar*)			X	X
Atlantic cod (*Gadus morhua*)		X	X	X
haddock (*Melanogrammus aeglefinus*)				
pollock (*Pollachius virens*)		X	X	X
whiting (*Merluccius bilinearis*)			X	X
offshore hake (*Merluccius albidus*)				
red hake (*Urophycis chuss*)			X	X
white hake (*Urophycis tenuis*)			X	X
winter flounder (*Pleuronectes americanus*)	X	X	X	X
yellowtail flounder (*Pleuronectes ferruginea*)	X	X		
windowpane flounder (*Scopthalmus aquosus*)	X	X	X	X
American plaice (*Hippoglossoides platessoides*)	X	X	X	X
ocean pout (*Macrozoarces americanus*)	X	X	X	X
Atlantic halibut (*Hippoglossus hippoglossus*)	X	X	X	X
Atlantic sea scallop (*Placopecten magellanicus*)	X	X	X	X
Atlantic sea herring (*Clupea harengus*)		X	X	X
Atlantic mackerel (*Scomber scombrus*)			X	X

Source: NOAA 2005, 2006*b*.

Potential Effects

MCT Seagen, Lunar RTT, and Verdant turbines are being considered for use at the Western Passage site. This site is characterized by deep water (55 m or more), fast current, and large areas of rock, gravel, and sand substrate (Figure 2-16). By locating the project on areas of rock substrate, project construction will not result in sediment re-suspension and scour will not occur during operation of the project. Areas of gravel and sand substrate may be more prone to scour. The underwater transmission cable will be run to Eastport passing Dog Island. This route crosses rock substrate; consequently, re-suspension of sediments during construction and scour resulting from project operation is not expected to be an issue (Figure 2-16).

As with the sites in Nova Scotia and New Brunswick, because of the hard substrates in the area, the transmission cable will likely be anchored to the sea bed. A fishing and anchor exclusion area will consequently be required along the project transmission cable route to prevent damage to ships, their equipment, and the project.

From consultation with the MDMR, the primary issue identified for this site is navigation (pers. comm., D. Etnier, MDMR, December 15, 2005 and Lt. Alan Talbot, Maine Marine Patrol, December 16, 2005). As discussed above, the principal navigation entrance to Passamaquoddy and Cobscook Bays is around the northern end of Campobello Island through Head Harbor Passage. This passage is deep and generally clear of dangers. South of Deer and Indian Islands, incoming vessels enter Friar Roads before turning north to approach the entrance to Western Passage. The safest route for navigation is toward the U.S. side of the entrance, which is free of turbulence (Hagerman and Bedard 2005*a*). This also represents the only access to the St. Croix River without going into Canadian waters. Consequently, the proposed project site is heavily used (pers. comm., D. Etnier, MDMR, August 16, 2005). This also is the best location for a tidal in-stream energy project (Hagerman and Bedard 2005*a*).

The depth at the proposed project site is 55 m, and if a Lunar or MCT turbine were installed, there would be ample clearance for navigation, even by deep-draft commercial shipping (see discussion for New Brunswick site above). Depending on the exact siting of the project, maintenance or other activities requiring access to the TISEC project may be disrupted when commercial ships pass through Western Passage.

Because the proposed project site has very fast currents and deep water, little fishing occurs (pers. comm., Lt. Alan Talbot, Maine Marine Patrol, December 16, 2005). A potential conflict with area salmon farms would arise if excessive amounts of tidal current energy were withdrawn from the channel flow, reducing the natural flushing action through salmon-rearing pens. As previously mentioned, EPRI is planning to withdraw no more than 15 percent of the cross-sectional base resource. This is not expected to result in any negative effect (Hagerman and Bedard 2005*a*).

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. U.S. and Maine-listed threatened and endangered species that may occur in the project area are listed above in Table 2-1. In addition all marine mammals are protected in U.S. waters by the MMPA[14]. Consultation with the

[14] The 1972 MMPA is the principal federal law that guides marine mammal conservation. The MMPA prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

NMFS and USFWS regarding potential project effects to species protected by the ESA and MMPA will be required during permitting of this project.

As discussed above in Section 2.2.2.1, there is little information as to whether, and if so, to what degree, tidal turbines cause mechanical and flow-related injuries to fish or other marine fauna. Risk of collision of fish or marine mammals with turbine blades is thought to be extremely low (RGU 2002). Verdant is currently planning to conduct a hydroacoustic field study to assess the potential for injury to fish resulting from operation of its proposed RITE project in New York. Because of the open nature and slower operating speed of a TISEC turbine, as compared to a conventional hydro turbine or a boat propeller, combined with the fact that many marine organisms have high perceptive powers and agility, giving them the ability to avoid collisions, it is expected that TISEC turbines will have minimal effects on fish and other marine life. However, without any studies having yet been completed, this has not yet been confirmed.

The Cobscook Bay area has the highest concentration of nesting bald eagle pairs in the state (MNAP 2005). Because the project is located offshore of the city of Eastport, it is not anticipated that any bald eagle nests are in the vicinity of the project area. However, as the project proceeds, the Maine Department of Inland Fisheries and Wildlife (MDIFW) should be consulted to confirm this. Any disturbance associated with construction activities or subsequent periodic boat activity associated with project maintenance would be temporary and is unlikely to significantly disrupt bald eagles visiting the project area. Turbines will be located deep in the water and will not affect foraging eagles.

As discussed above for the New Brunswick site, from initial discussion with biologists, the main concern with regard to marine mammals was whether the TISEC units make excessive noise. Underwater noise is expected to be relatively low because of the low speed of operation, especially in comparison to a boat propeller, and the need to minimize cavitation (Bedard et al. 2005). It is not expected that the turbine would directly harm marine mammals because they would be able to see and hear the device and swim around the unit (pers. comm., Lei Harris, DFO, January 6, 2006). As with Head Harbor passage, it is expected that Western Passage is not an area where whale concentration is high. It is expected that the risks to marine mammals from this project are expected to be negligible, unless noise is determined to be an issue.

Loggerhead turtles (*Caretta caretta*) rarely occur in the Gulf of Maine and leatherback turtles (*Dermochelys coriacea)* occur primarily in offshore waters of the Gulf. Because the proposed project will be located nearshore, it is not expected to have any effect on these species.

American eels are currently being considered for designation as endangered under the ESA. This catadromous species spawns in the Sargasso Sea, elvers drift with prevailing ocean currents, they ascend rivers where they may live for 12 or more years, and then adults return to the Sargasso Sea to spawn. Migrating eels may therefore likely occur along the Gulf of Maine and the proposed project area. As with Atlantic salmon, it is not expected that a TISEC project will negatively affect migrating or resident eels.

The proposed development of the pilot scale and commercial scale project is not expected to affect EFH for the above-listed species (Table 2-2), many of which find key habitat either in nearshore estuarine waters or in more offshore habitats. Nonetheless, an EFH analysis will likely need to be conducted for each of the species listed as part of any federal permitting process.

The U.S. onshore interconnection point for a tidal energy project in Western Passage would be to the Bangor Hydro-Electric Company utility grid. A 34.5 kV transmission line runs adjacent to state Route 190, and 12.5 kV distribution lines run throughout the island, which minimizes the overland distance for grid interconnection to either a 500 kW demonstration or a 10 MW commercial scale TISEC project. It is proposed that the transmission cable would be run past Dog Island to Eastport. The shore is rocky in this area.

2.3.2.4 Massachusetts

The Muskeget Channel site, located east of Chappaquiddick Island in Nantucket Sound, was selected for development of the TISEC project in Massachusetts. Power generated by the project is expected to be transmitted by an underwater transmission cable to a shore station on Chappaquiddick Island where a transmission line would need to be constructed in order to connect to the grid.

Site Description

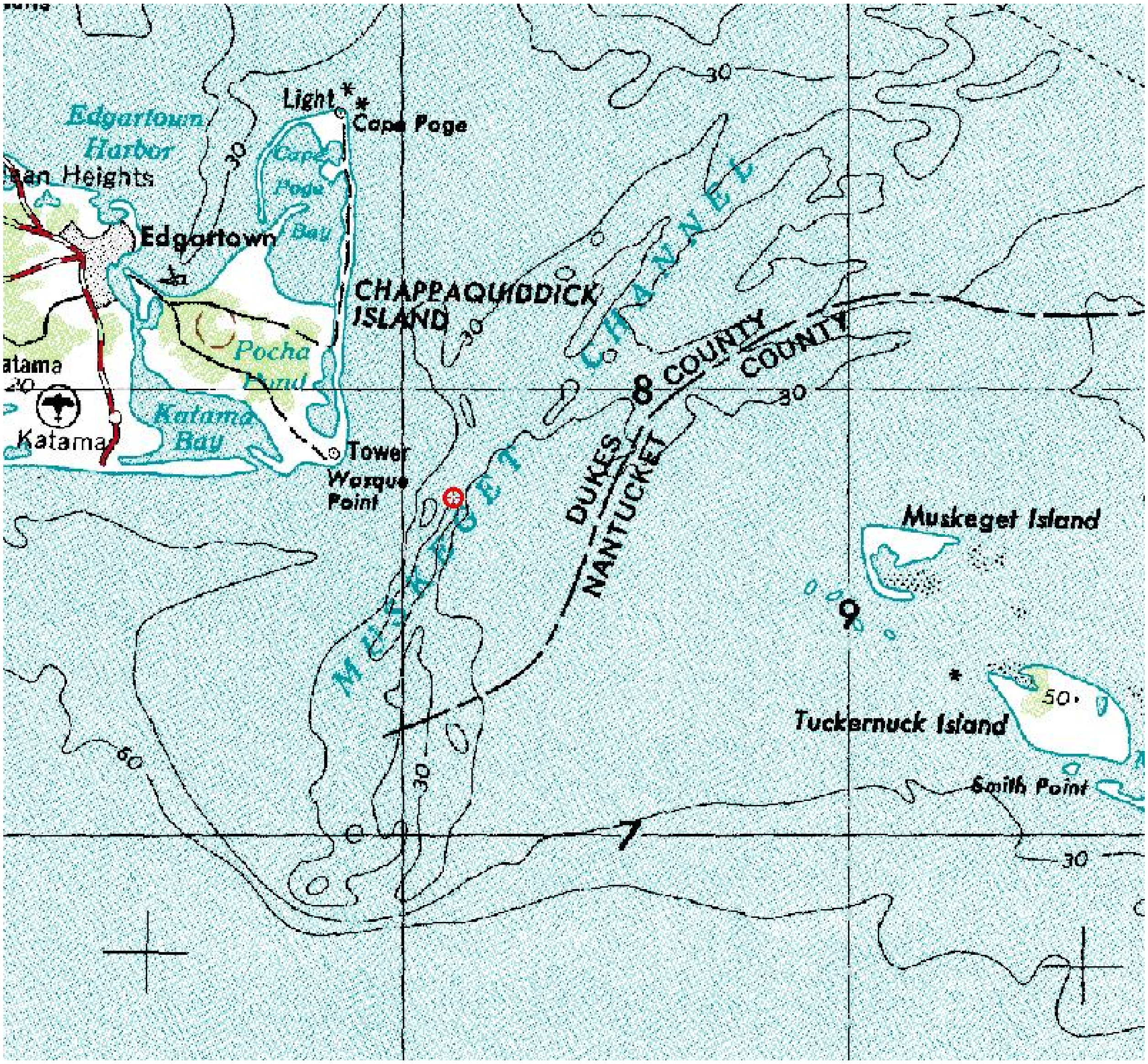
Muskeget Channel is an opening about six miles (10 km) wide on the south side of Nantucket Sound between Muskeget and Chappaquiddick Islands (Figures 2-17). The potential TISEC project site is located in the deepest part of the channel (65 to 135 feet [20 to 40 m]), which is about 0.6 miles (1 km) wide and is located about 1.5 miles east-southeast of Wasque Point at the southeastern corner of Chappaquiddick Island (Figure 2-17). Wasque Shoal rises abruptly from deep water on the west side of Muskeget Channel, and at low tide the portion of this shoal located two miles south of Wasque Point becomes exposed. Muskeget Shoal occurs on the east side of Muskeget Channel and has a minimum depth of five feet (Figure 2-18) (Hagermann and Bedard 2005*b*). The general area around Muskeget Channel is characterized by shallow depths, temporary shoals, and permanent islands (USFWS 1991; USACE 2004).

The mean range of tide is 1.9 feet. The currents through the channel are strong, having a velocity of 2.0 m/s (3.8 knots) on the flood and 1.7 m/s (3.3 knots) on the ebb about 2.5 km (1.5 miles) east of Wasque Point (Hagermann and Bedard 2005*b*). The sediment in the proposed project area within Muskeget Channel consists of gravel sediment. Sand and gravelly sediment[15] is prevalent just to the south of the project area. Areas of gravel and sand occur along the eastern shore of Chappaquiddick Island (USGS 2006).

Both Muskeget and Tuckernuck Islands, located about 5.5 to 7.0 miles from the proposed site respectively, are predominately in private ownership (Figure 2-17). Parts of Muskeget Island are owned by the Town of Nantucket. There are approximately 30 to 35 seasonally occupied dwellings on Tuckernuck Island (Hagermann and Bedard 2005*b*).

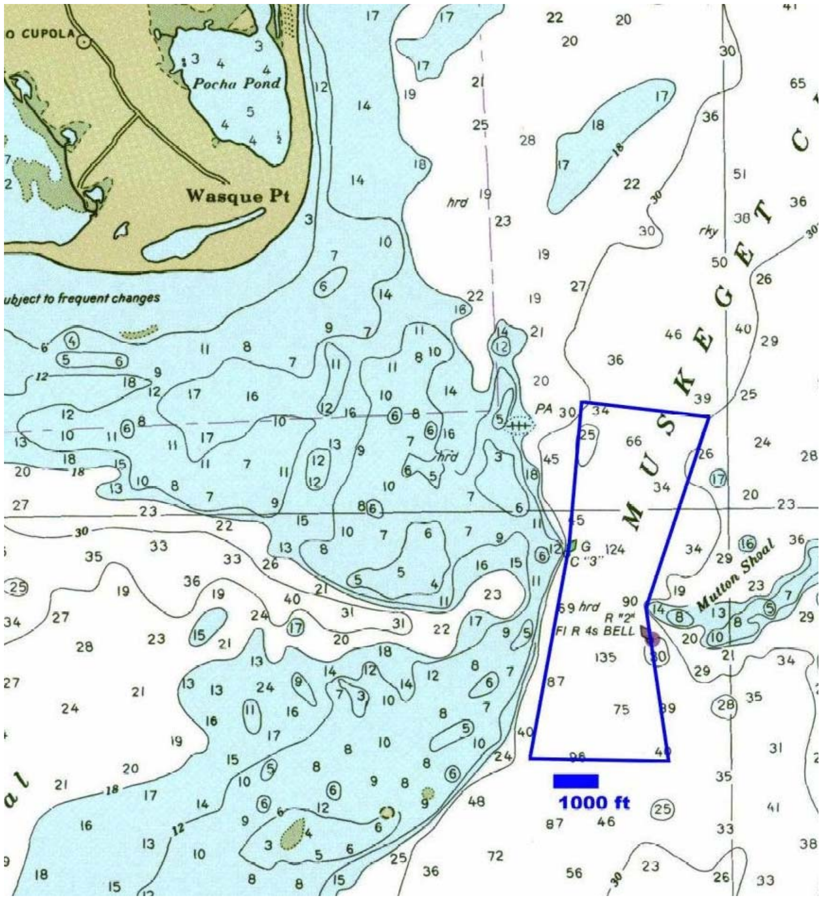
[15] USGS (2006) defines these sediment types as follows: Gravel – sediment whose main phase is gravel (>50 percent), also rocky bottom, boulders; Gravelly – sediment with significant amounts of gravel (>10%, but < 50 percent); Sand – sediment whose main phase is sand without significant gravel or mud.

FIGURE 2-17
PROPOSED MUSKEGET CHANNEL TISEC PROJECT SITE



Source: Hagermann and Bedard 2005*b*.

FIGURE 2-18
MUSKEGET CHANNEL CHART



Source: Hagermann and Bedard 2005*b*.

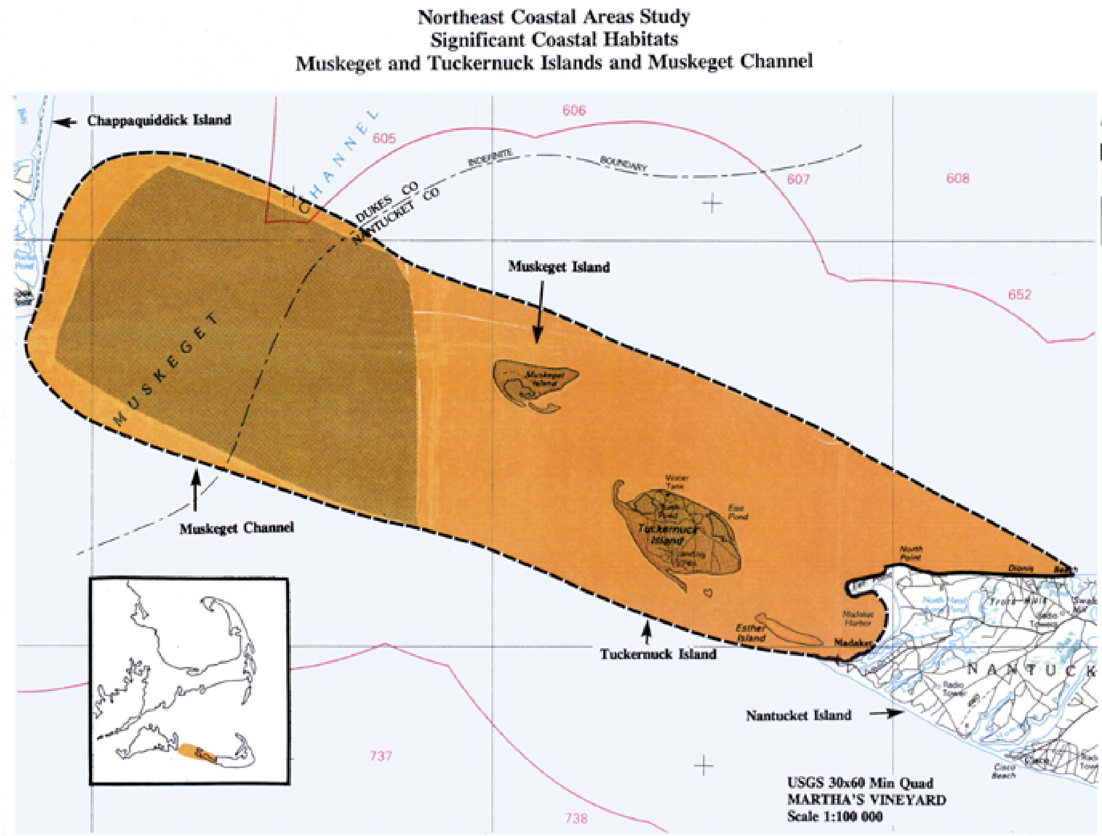
The proposed project will occur in part of two adjacent USFWS-designated Significant Coastal Habitats: 1) Muskeget Channel and Muskeget and Tuckernuck Islands (Figure 2-19); and 2) Martha's Vineyard Coastal Sandplain and Beach Complex (Figure 2-20) (USFWS 1991)[16]. Fish species that typically occur in the proposed project area include bluefish (*Pomatomus saltatrix*), winter flounder, striped bass, Atlantic cod, and Atlantic bonito (*Sarda sarda*). The shallow waters of Muskeget Channel and the areas surrounding Muskeget and Tuckernuck Islands are very productive for marine fish, shellfish, and eelgrass (*Zostera marin*a). Because of the depth, high velocity, and gravel substrate of the main part of Muskeget Channel, eelgrass beds are not expected to occur where the TISEC turbine/s would be located.

Large numbers of harbor seals and gray seals use the broad sandspits associated with Muskeget, Tuckernuck, and Skiff Islands (west side of Muskeget Channel off Martha's Vineyard) and coastal beaches of Martha's Vineyard as haulout points (USFWS 1991). Harbor seals pup in waters to the north of Massachusetts, but many juveniles overwinter in Nantucket Sound and adults can occur in the Sound year round. While Tuckernuck and Muskeget Islands represent important overwintering habitat for harbor seals (USACE 2004), they can be found in all nearshore waters (Waring et al. 2001). Muskeget Island is one of only two breeding locations for gray seal in the U.S. (USFWS 1991)[17]. NOAA has designated Muskeget Island as habitat for year-round breeding populations of gray seals (Waring et al. 2001), though the Massachusetts Natural Heritage Endangered Species Program (NHESP) reports that use is highest during winter and spring (NHESP 2002). During a 1999 survey between Woods Hole and Isle of Shoals, New Hampshire, 93 percent of the 5,600 gray seals documented were seen at Muskeget Island and Monomoy Island, located off of the elbow of Cape Cod (Waring et al. 2001). Gray seals will occasionally haul-out at Wasque and Cape Poge and frequently occur along its shores, primarily during winter months (Massachusetts Trustees of Reservations 2006). Therefore, it can be expected that gray seals, as well as harbor seals, will pass through the proposed project site.

[16] In 1990, the USFWS identified significant coastal habitats - those areas in southern New England in need of protection for fish and wildlife habitat and the preservation of biological diversity. The USFWS does not identify any regulatory requirements that result from this designation (USFWS 1991).

[17] Because of the presence of breeding gray seals, Muskeget Island is designated as a National Natural Landmark (USFWS 1881).

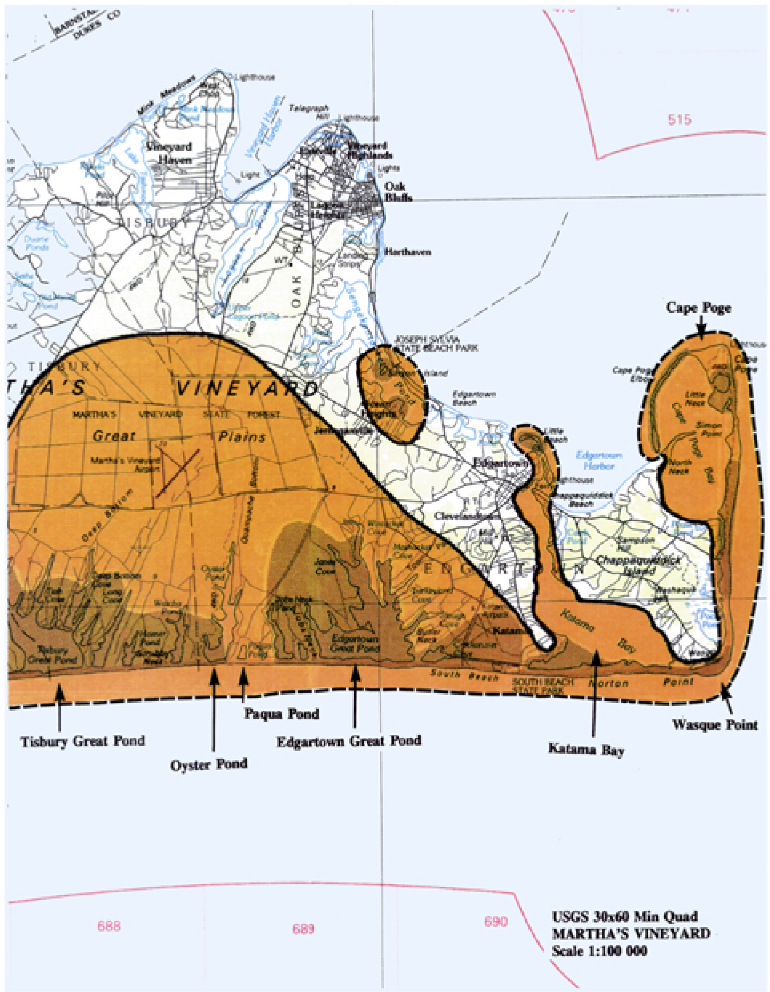
FIGURE 2-19
MUSKEGET AND TUCKERNUCK ISLANDS AND MUSKEGET CHANNEL, SIGNIFICANT COASTAL HABITAT



Source: USFWS 1991.

FIGURE 2-20
MARTHA'S VINEYARD COASTAL SANDPLAIN AND BEACH COMPLEX, SIGNIFICANT COASTAL HABITAT (EASTERN PORTION)

Northeast Coastal Areas Study
Significant Coastal Habitats
Martha's Vineyard Coastal Sandplain and Beach Complex, Part 2



Source: USFWS 1991.

Other marine mammals that may occur in Nantucket Sound include harp seal, hooded seal, humpback whale, fin whale, northern Atlantic right whale, Atlantic white-sided dolphin, harbor porpoise, long-finned pilot whale (*Globicephala melas*), and minke whale. Nantucket Sound does not sustain high densities of food sources for the large species of whales (humpback, fin, right — all federally-listed endangered species). Primary feeding grounds for these species are to the north-northeast in Stellwagen Bank, Cape Cod Bay, and the Gulf of Maine. Based on historic information, Nantucket Sound is not considered to be important habitat for these species (USACE 2004).

Observation of sea turtles is rare in Nantucket Sound, though Loggerhead, Kemp's Ridley (*Lepidochelys kempii*), and leatherback turtles are known to occur. Of these three species, leatherbacks are more common in Massachusetts than the other two species; Kemp's Ridley turtles only occur in this area occasionally (USACE 2004).

The project area represents rich feeding grounds for terns and gulls during summer and sea ducks during winter. Thousands of common eiders and three species of scoter also occur in this area. Long-tailed ducks (*Clangula hyemalis*) visiting the Muskeget Channel and Muskeget and Tuckernuck Islands area represent the largest concentration of this species in the western Atlantic with over 150,000 individuals having been documented. Large colonies of herring gull and great black-backed gull occur on Muskeget Island (USFWS 1991).

Recently, aerial and boat surveys of birds were conducted in Nantucket Sound from March 2002 to March 2004 (USACE 2004) and a number of waterbirds were documented. Waterbirds observed in the proposed project vicinity include the following (birds observed in Tuckernuck Shoal[18] area unless otherwise indicated): Wilson's storm-petrals (*Oceanodroma leucorhoa*), northern gannets (*Morus bassanus*), double-crested and great cormorants (*Phalacrocorax carbo*) (Muskeget Island vicinity), common eiders (between Tuckernuck Shoal and Martha's Vineyard - nest on Muskeget Island), long-tailed ducks, three species of scoter, red-breasted merganser (*Mergus serrator*) (near Muskeget and Tuckernuck Islands), a variety of gulls, a variety of terns (Tuckernuck Shoal and off Muskeget Island), auks (alcid sp.), American black ducks (Muskeget Island), and Canada geese (Muskeget Island, Tuckernuck Island). The following shorebirds were also observed in the project area: American oystercatcher (*Haematopus palliates*) (Muskeget Island), red knot (*Calidris canutus*)

[18] Tuckernuck Shoal is located about 10 miles northeast of the proposed project site.

and sandpipers (off Cape Poge, Martha's Vineyard), and dunlins (*Calidris alpine*) (Muskeget Island) (USACE 2004).

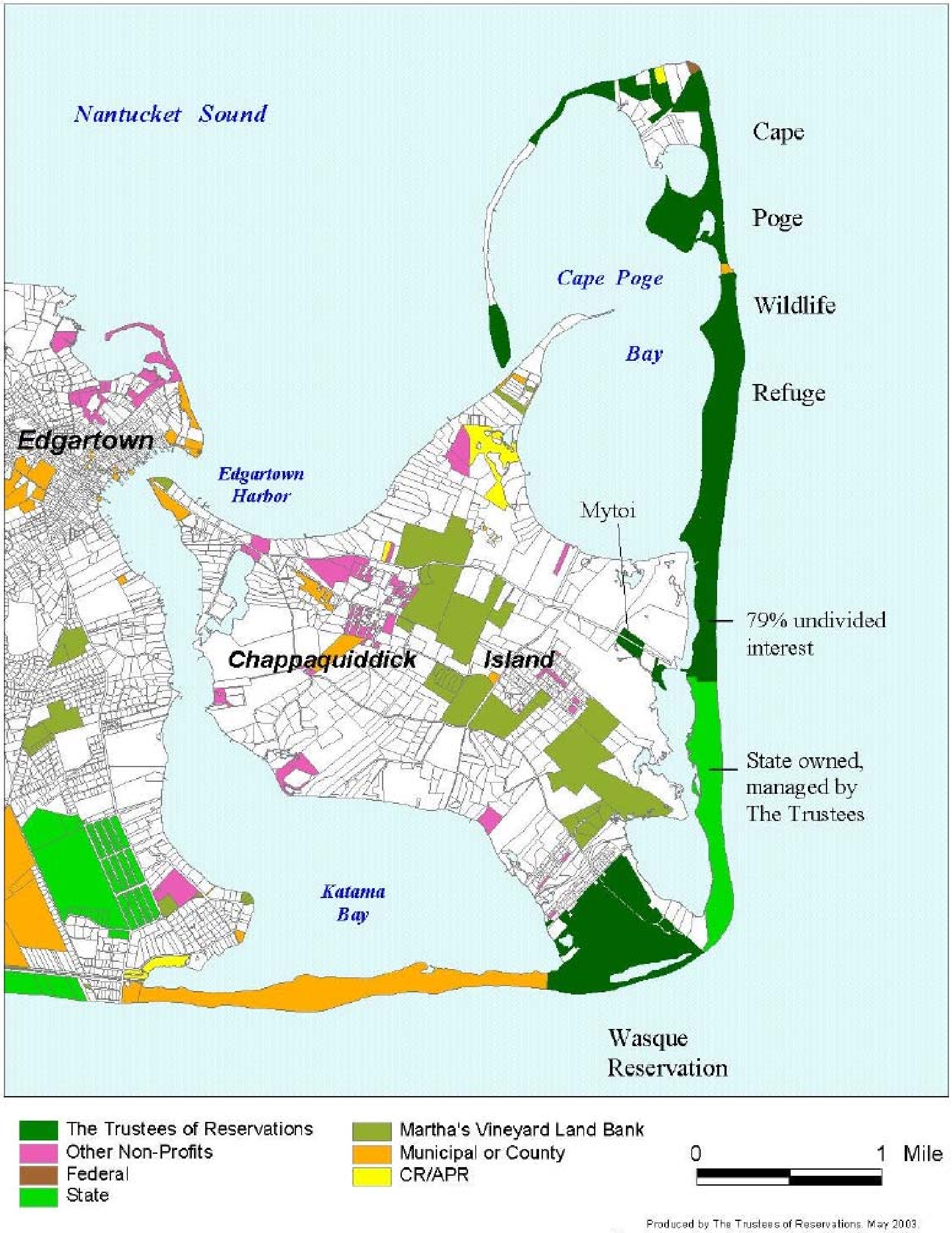
As previously mentioned, power generated by the project will be transmitted by an underwater transmission cable to a shore station on Chappaquiddick Island. The nearest interconnection point is a 4.8 kV distribution circuit on the island that could accommodate a 500 kW pilot demonstration plant. Any larger plant would require significant upgrades. No electric infrastructure exists beyond Dike Road Bridge, which crosses the waterway east of Mytoi Reservation, just inland of the beach by the east side of the island (Figure 2-21). It is 3.5 miles (5.5 km) from the proposed turbine deployment location (mid channel) to Dike Road Bridge and about ¼ mile (0.4 km) from the nearest shore location to the Dike Road Bridge. If the transmission line came ashore at a different location, such as Wasque Point, the distance to connect to the grid would be greater.

The entire eastern-most shore of Chappaquiddick Island is part of the above mentioned Martha's Vineyard Coastal Sandplain and Beach Complex, a USFWS-designated Significant Coastal Habitat (Figure 2-20 (USFWS 1991). In addition, the Massachusetts Trustees of Reservations owns and manages the eastern shoreline from Cape Poge to Wasque and an additional nearshore area through the following three reservations[19] (Figure 2-21) (Massachusetts Trustees of Reservations 2006):

- Cape Poge Wildlife Refuge (516 acres) - includes a majority of the east side of Chappaquiddick Island;
- Wasque (200 acres), near Wasque Point on the southeastern corner of Chappaquiddick Island; and
- Mytoi (14 acres), located just inland of the beach on both sides of the Dike Road by the bridge accessing the beach.

[19] Results of a 1999 assessment found that 33 percent of Chappaquiddick is protected by state, county, or local government or by private conservation organizations (Massachusetts Trustees of Reservations 2006).

FIGURE 2-21
MAP OF CHAPPAQUIDDICK ISLAND INDICATING PROTECTED OPEN SPACE



Source: Massachusetts Trustees of Reservations 2006; map for planning purposes only.

The east side of Chappaquiddick Island consists of a nearly continuous barrier beach extending seven miles from Cape Poge to Wasque Point (Figure 2-21) (Massachusetts Trustees of Reservations 2006). Habitat along the shore includes unvegetated beach face and berm, thinly vegetated foredunes, and more stable and heavily vegetated inner dunes. Typical vegetation associated with the foredunes include American beach grass (*Ammophila breviligulata*) and seaside goldenrod (*Solidago sempervirens*). Inner dune vegetation includes bayberry (*Myrica pensylvanica*), saltspray rose (*Rosa rugosa*), poison ivy (*Toxicodendron radicans*) and winged sumac (*Rhus copallina*) (USFWS 1991).

Other natural communities that occur in the Cape Poge Wildlife Refuge and Wasque Reservation, through which project power may need to be transported, include coastal salt ponds, sandplain grasslands and heathlands (an important feature of Wasque), maritime eastern red cedar (*Juniperous virginiana*) woodland, maritime shrublands, pitch pine (*Pinus rigida*) and oak forests (these forests along with an understory of black huckleberry [*Gaylussacia baccata*] and other shrubs cover most of Chappaquiddick Island), interdunal swales, deep emergent marsh, and salt marsh (especially prevalent around Poucha Pond, which is near Wasque Point). Inland of the barrier beach, open water extends from Cape Poge Bay on the north side of Chappaquiddick Island to Poucha Pond. The salt marshes and waters of Cape Poge Bay and Poucha Pond provide important nursery habitat for a variety of finfish and shellfish.

A number of U.S. and Massachusetts-listed threatened and endangered species may occur in the marine or beach portion of the project area. Table 2-3 lists marine species that occur in Dukes County (birds and sponge) or in Commonwealth marine waters (turtles and cetaceans – not listed by county).

TABLE 2-3
THREATENED AND ENDANGERED SPECIES THAT MAY OCCUR IN MARINE WATERS OF THE PROJECT AREA

Species		State Status*	Federal Status*
Piping plover	*Charadrius melodus*	T	T
Roseate tern	*Sterna dougalli*	E	E
Common tern	*Sterna dougallii*	SC	
Arctic tern	*Sterna paradisaea*	SC	
Least tern	*Sterna antillarum*	SC	
Leach’s storm-petral	*Oceanodroma leucorhoa*	E	
Common moorhen	*Gallinula chloropus*	SC	

Species		State Status*	Federal Status*
Loggerhead seaturtle	*Caretta caretta*	T	T
Leatherback seaturtle	*Dermochelys coriacea*	E	E
Green seaturtle	*Chelonia mydas*	T	T
Hawksbill seaturtle	*Eretmochelys imbricata*	E	E
Kemp's Ridley seaturtle	*Lepidochelys kempii*	E	E
Northern right whale	*Eubalaena glacialis*	E	E
Humpback whale	*Megaptera novaeangliae*	E	E
Fin whale	*Balaenoptera physalus*	E	E
Sei whale	*Balaenoptera borealis*	E	E
Blue whale	*Balaenoptera musculus*	E	E
Sperm whale	*Physter catodon*	E	E
Smooth branched sponge	*Spongilla aspinosa*	SC	

* E - endangered, T- threatened, SC – special concern
Source: MDFG 2006.

The USFWS (1991) reports that a thousand or more roseate terns feed in the marine waters of the project vicinity (see Figure 2-19) as they prepare for their migration south. As discussed earlier, Nantucket Sound does not sustain high densities of food sources for the large species of whales (humpback, fin, right) and it is not considered to be important habitat for these species. While a number of species of sea turtles are listed as occurring in Massachusetts waters, only three species — loggerhead, Kemp's Ridley, and leatherback turtles are known to occur in Nantucket Sound, and loggerhead and Kemp's Ridley turtles are not common in the proposed project area.

The Massachusetts Trustees of Reservations has compiled a list of rare species that are of management concern in the eastern part of Chappaquiddick Island (Table 2-4), the area where the underwater transmission cable would make landfall and the shore station and connection to the grid would be constructed.

TABLE 2-4
SPECIES OF MANAGEMENT CONCERN – CAPE POGE WILDLIFE REFUGE AND WASQUE RESERVATION

Common Name	Scientific Name	State Rank*	Federal Rank*
Gray Seal	*Halichoerus grypus*	SC	
Harbor Seal	*Phoca vitulina concolor*		
Saltmarsh Sharp-tailed Sparrow	*Ammodramus caudacutu*	WL	
Short-Eared Owl	*Asio flammeus*	E	
Piping Plover	*Charadrius melodus*	T	T
Northern Harrier	*Circus cyaneus*	T	
Snowy Egret	*Egretta thula*	WL	
American Oystercatcher	*Haematopus palliatus*	Uncommon	
Osprey	*Pandion haliaetus*	WL	
Savanna Sparrow	*Passerculus sandwichensis*	WL	

Common Name	Scientific Name	State Rank*	Federal Rank*
Least Tern	*Sterna antillarum*	SC	
Roseate Tern	*Sterna dougallii*	E	E
Common Tern	*Sterna hirundo*	SC	
Arctic Tern	*Sterna paradisaea*	SC	
Purple Tiger Beetle	*Cicindela purpurea*	SC	
Juniper Hairstreak	*Mitoura grynea*	Unusual	
Chain Dot Geometer	*Cingilia catenaria*	SC	
Nantucket Shadbush	*Amelanchier nantucketensis*	SC	
Butterfly-Weed	*Asclepias tuberosa*	WL	
Bushy Rockrose	*Helianthemum dumosum*	SC	
New England Blazing Star	*Liatris borealis*	SC	
Sandplain Flax	*Linum intercursum*	SC	
Sea-Beach Knotweed	*Polygonum glaucum*	SC	
Bristly Foxtail	*Setaria geniculata*	SC	
Sandplain Blue-Eyed Grass	*Sisyrinchium arenicola*	SC	
Little Ladies'-Tresses	*Spiranthes tuberosa*	WL	

*E – endangered, T – threatened, SC – special concern, WL – watch list.
Source: Massachusetts Trustees of Reservations 2006.

The coastal beach along the east side of Chappaquiddick Island, along with the south side of Martha's Vineyard, represents important habitat for nesting piping plovers (*Charadrius melodus*) and least tern (*Sterna antillarum*). Other isolated habitats along the beach and islands of the coastal habitat unit (exact locations not specified) provide important habitat for common tern (*Sterna hirundo*), roseate tern (*S. dougallii*), American oystercatcher, northeastern beach tiger beetle (*Cincindela d. dorsalis*), a U.S.-threatened species, and sea-beach knotweed (*Polygonum glaucum*) and sea-beach pigweed (*Amaranthus pumilis*), both regionally rare plant species that grow on several of the beaches in this area. Bald eagles occasionally overwinter in the vicinity of Katama Bay and other ponds and embayments along the south side of Martha's Vineyard and migrating peregrine falcons (*Falco peregrinus*) are common during spring and fall (USFWS 1991). As the project progresses and the terrestrial areas that will be affected by the project are clarified, some of these species will likely be determined to not be of concern.

In the project area, NMFS has identified EFH for a number of species and lifestages in the 10-x-10-minute-square area that includes the proposed project site (Table 2-5).

TABLE 2-5
FISH SPECIES/LIFESTAGES FOR WHICH EFH DESIGNATED IN A 10-X-10-MINUTE-SQUARE AREA THAT INCLUDES THE PROPOSED MUSKEGET CHANNEL TISEC SITE

Species		Eggs	Larvae	Juveniles	Adults
Atlantic cod	*Gadus morhua*				X
winter flounder	*Pleuronectes americanus*	X	X	X	X
yellowtail flounder	*Pleuronectes ferruginea*			X	
long finned squid	*Loligo pealei*			X	X
Atlantic butterfish	*Peprilus triacanthus*	X	X	X	X
Atlantic mackerel	*Scomber scombrus*	X	X	X	X
summer flounder	*Paralicthys dentatus*	X	X	X	X
scup	*Stenotomus chrysops*			X	X
black sea bass	*Centropristus striata*		X	X	X
surf clam	*Spisula solidissima*			X	X
king mackerel	*Scomberomorus cavalla*	X	X	X	X
Spanish mackerel	*Scomberomorus maculatus*	X	X	X	X
cobia	*Rachycentron canadum*	X	X	X	X
blue shark	*Prionace glauca*				X
bluefin tuna	*Thunnus thynnus*			X	X
shortfin mako shark	*Isurus oxyrhyncus*			X	
little skate	*Leucoraja erinacea*			X	X
winter skate	*Leucoraja ocellata*			X	X

Source: NOAA 2005, NOAA 2006*b*.

Some of these species are unlikely to occur in the deep part of the channel where the turbines will be located. For example, summer flounder, scup (*Stenotomus chrysops*), and black sea bass (*Centropristis striata*) prefer estuaries and sandy bottoms and yellowtail flounder (*Pleuronectes ferruginea*) prefer sandy bottoms (NOAA 2006*c*).

Recreation, commercial fishing, and marine cargo vessels use Muskeget Channel as an offshore entry point to the Sound and for access to commercial and recreational ports (Nantucket, Vineyard Haven, and Edgartown Harbors). Increased boat traffic occurs in Nantucket Sound from April through October (USACE 2004). Muskeget Channel is partly marked by buoys, but the high tidal currents make navigation dangerous (NOAA 1994). Consequently, larger vessels typically avoid Muskeget Channel due to the shallow depths and high currents (USACE 2004).

Specific information describing commercial fishing in Muskeget Channel was not found, though more general information is available for Nantucket Sound. The top fish species caught by commercial fisheries in Nantucket Sound are squid, Atlantic mackerel (*Scomber scombrus*), black sea bass), summer flounder, scup (*Stenotomus chrysops*), menhaden (*Brevoortia tyrannus*), butterfish (*Peprilus triacanthus*), tautog (*Tautoga onitis*), winter flounder, and bluefish. Commercial fishing in the Nantucket Sound employs otter trawls, gill nets, fish weirs, pound nets, seines, a variety of pots and traps, and hand lines. Shellfish harvested in Nantucket Sound include mussels, quahogs (*Mercenaria mercenaria*), bay scallops (*Argopecten irradians*), surf calms (*Mactra veneriformis*), soft shell clams (*Mya arenaria*), and conch (*Strombus* sp.). Shellfish are collected using fish pots, rakes, and different types of dredges (USACE 2004). On Chappaquiddick Island, the eel grass beds of Cape Poge Bay support a high-quality, though sporadic (i.e., prone to boom and bust cycles) scallop population and often provides one of the largest sources for scallops in Massachusetts (Massachusetts Trustees of Reservations 2006). The lobster fishery of Nantucket Sound is small, constituting only 0.4 percent of the Massachusetts inshore harvest in 1999 (USACE 2004). The highest level of recreational fishing in Nantucket Sound occurs from June through September (USACE 2004) with bluefish, Atlantic mackerel, scup, striped bass, winter flounder, summer flounder, bonito, false albacore (*Euthynnus alletteratus*), menhaden, and tautog commonly sought by anglers (USACE 2004; Martha's Vineyard Online 2002). Surf casting for bluefish and stripe bass is popular off of Wasque Point in May and June (Martha's Vineyard Online 2002). From a 2002 interview of 30 party and charter boat captains that fish in Nantucket Sound, Muskeget Channel was one of 14 areas listed as being fished most (USACE 2004).

As indicated in Figure 2-21, much of the eastern shore of Chappaquiddick Island is owned by the Massachusetts Trustees of Reservations and the state and is open to the public. Popular activities at Cape Poge and Wasque are swimming, sunbathing, picnicking, hiking, fishing, enjoying the scenery, and 4-wheel driving on the dune road system. Access to the eastern shore is over the Dike Bridge. The large beachfront is popular with tourists and summer residents, and over 14 miles of dune roads and walking trails provide access to over-sand vehicles and walkers (via a permit system) (Massachusetts Trustees of Reservations 2006). The sand roads along with a small number of large homes represent the extent of development in the Cape Poge Wildlife Refuge area (USACE 2004). At Wasque, houses occur along the entire upland boundary. About half of the oceanfront beach is restricted to pedestrian and wildlife use only while vehicle access is allowed to the remaining half (Massachusetts Trustees of Reservations 2006).

Potential Effects

MCT Seagen, Lunar RTT, and Verdant turbines are being considered for use at the Muskeget Channel site. The depths at the proposed turbine deployment site are 20 to 40 m (65 to 135 feet). The underwater transmission cable is planned to be run from the units to Chappaquiddick Island. The location of landfall has not yet been proposed.

Because Muskeget Channel provides marine access in and out of Nantucket Sound for ships passing between Martha's Vineyard and Nantucket, the potential effects of project development on marine navigation will likely be a concern. Due to the relatively shallow depths of the channel, only the Verdant units are likely to not obstruct shipping traffic. Lunar and MCT units would need to be marked appropriately so that larger ships could go around them. If the underwater transmission cable is anchored to the bottom of the channel, a fishing and anchor exclusion area will likely be needed around the units and the portions of the transmission cable that are anchored to the seabed. If the cable is buried, the chances of the cable catching anchors or fishing gear and long term disturbance to any sensitive habitats such as eelgrass beds can be minimized.

Coarse-grained armored bottom sediments typically occur in channels having high current velocities that preclude deposition of fine-grained sediments (USACE 2004). While gravel sediments are known to occur in the proposed TISEC turbine site, the degree to which this sediment is armored is unknown. It is therefore not known whether the site will be resistant to scour, nor can it be concluded to what degree existing habitat will be affected. The developer should consult with local government resource agency staff in siting the underwater transmission cable in order to assess nearshore sediment types and habitats and how to best minimize potential effects of installation. EFH assessment, which is typically a desktop analysis, will likely need to be conducted for each of the species listed as part of any federal permitting process. Areas of gravel and sand occur along the eastern shore of Chappaquiddick Island (USGS 2006), and open trenching may be appropriate in this area in order to bury the underwater transmission cable. If concerns are raised regarding effects to these habitats, HDD may be appropriate for installing the cable in nearshore waters, under the beach, and to the shore station.

For the Muskeget Channel area, the USFWS (1991) stated that key concerns are the protection of the important natural resource values including waterfowl, colonial nesting birds, and pinniped haul out and pupping habitat. The USFWS also stated the Commonwealth and federal resource agencies, the Coast Guard, and private landowners (on the islands), should work together to manage the area and to ensure consideration of the high ecological values of the area, especially in relation to any dredging operations, regulation or approval of shipping lanes or oil spill contingency plans (USFWS 1991).

The eastern portion of Chappaquiddick Island, especially the barrier beach and nearshore areas, are of particular importance from a conservation standpoint. This is evidenced by the establishment of three reservations — Cape Poge Wildlife Refuge, Wasque, and Mytoi, and the inclusion of the area in the Martha's Vineyard Coastal Sandplain and Beach Complex, a USFWS-designated Significant Coastal Habitat. If the proposed project's power is to be brought ashore on Chappaquiddick Island, which is likely desirable due to it being adjacent to the proposed Muskeget Channel site, these protected areas will need to be used for making landfall with the underwater transmission cable, constructing a shore station, and connecting to the grid. The identified nearest grid connection would be on the west side of Dike Road Bridge, which may be the preferable transmission cable route. No transmission lines occur to the east of the bridge. Line extensions through either Wasque Reservation or Cape Poge would therefore likely be required. As the project proceeds and potential transmission routes are considered, the developer will need to consult with federal, state, and local resource agencies and management authorities to identify how to best proceed so as to minimize impacts to important biological, scenic, and recreation values that this area provides, including crossing of the water by the bridge.

As described above, a variety of species that are threatened, endangered, of special concern, or are otherwise of management concern have the potential to occur in the project area, both in Muskeget Channel and on Chappaquiddick Island. Any potential effects of project construction or operation on these species will be of concern and more detailed site specific information regarding these species will be needed. Section 7 of the ESA requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of these species. In addition, all marine mammals are protected in U.S. waters by the MMPA. Consultation with NMFS and USFWS regarding potential project effects to species protected by the ESA and MMPA will be required during permitting of this project. It will also be important for a developer to initiate consultation with the Massachusetts Natural Heritage and Endangered Species Program (MNHESP). By submitting a Rare Species Information Request Form to MNHESP, the developer will be able to determine what threatened and endangered species habitat likely occurs in the project area. Addressing endangered species concern is further discussed in Section 3.3, Massachusetts State Permitting Requirements.

Muskeget Island serves as important haul-out and breeding habitat for gray seals and haul-out habitat for harbor seals. Because the proposed project site is located about 5.5 miles from Muskeget Island, it is not expected that project construction activities will adversely affect seals using Muskeget Island (USACE 2004). During construction of the Nasrevet Wind Farm in Sweden, Westerberg (1999) reported that gray seals quickly became habituated to construction activities, including installation of pilings. Whales and sea turtles have also been reported to habituate to the presence and sound of boats (USACE 2004).

As previously discussed, there is little information as to whether, and if so, to what degree, tidal turbines cause mechanical and flow-related injuries to marine mammals or other marine fauna. Risk of collision of fish or marine mammals with turbine blades is thought to be extremely low (RGU 2002). Because of the open nature and slower operating speed of a TISEC turbine, as compared to a conventional hydro turbine or a boat propeller, combined with the fact that many marine organisms have high perceptive powers and agility, giving them the ability to avoid collisions, it is expected that TISEC turbines will have minimal effects on marine fauna. However, without any studies having yet been completed, this has not been confirmed.

Protection from human disturbance of beaches used by piping plovers and terns is important during their nesting season (mid-April to August). In addition, dune vegetation and other sensitive natural habitat communities are common on the east side of Chappaquiddick Island. It will be important for the developer of the project to work with government resource agencies to identify and avoid key nesting habitats. The Massachusetts Trustees of Reservations have developed the *Cape Poge and Wasque Management Plan*, published in 2004, which provides considerable information about the eastern part of Chappaquiddick Island, including detailed maps of the natural community types summarized above (Massachusetts Trustees of Reservations 2006).

The viewshed of the eastern side of Chappaquiddick Island is important from both land and sea, and many visitors enjoy the area by boat or canoe. Because of the relatively flat topography, the

Trustee's have expressed concern to poorly designed or badly located development, which in many areas could be seen for long distances. The Trustees of Reservations report that most visitors are attracted to the east side of Chappaquiddick Island because of the miles of beaches and ocean views and that consequently protection of the exceptional scenery is a priority, especially at the Cape Poge Wildlife Refuge. At Wasque, the Trustees focus on the management of the sandplain grasslands and heathlands in order to protect the scenic views and the important and rare heathland habitat (Massachusetts Trustees of Reservations 2006). Verdant, Lunar, and the Topless MCT Seagen units and underwater transmission cables will be obscured from view. Minimizing effects of project construction on existing recreation uses will be important. In addition, the developer will need to carefully plan, in consultation with appropriate resource agencies, the siting and design of the shore station and terrestrial grid connection so as to minimize aesthetic impacts.

2.4 Field Studies

Phase I activities of this project (the North American Tidal In Stream Energy Conversion Feasibility Demonstration Project) consist of the following:

- site survey and characterization;
- device selection, system level design;
- performance analysis,
- economic assessment; and
- summary of environmental, regulatory, and permitting issues (i.e., this report).

Phase II involves finalization of system design, initiation of permitting, and securing financing for the development of each project. Refining the system design for each site will be an important step to complete prior to initiating the permitting of each project. An important part of the permitting process will be consultation with resource agencies and other interested stakeholders to determine what field studies may be appropriate.

Potential field studies generally fall into two categories: characterization of existing resources (pre-deployment) and project impact assessment (post-deployment). If existing site information is not available, then field studies to characterize relevant resources may be required. These may include:

- Aquatic and terrestrial community;
- Benthic habitat characterization
- Substrate profiling/sediment characterization;
- Passage of fish and other marine life;
- Recreational use;
- Other marine uses;
- Aesthetic resources; and
- Historical resources.

Baseline assessments can frequently be accomplished through review of existing information and databases, in coordination with other proposed project siting evaluations (e.g., characterizing sediment types and presence of aquatic vegetation during bathymetric surveys conducted during siting), and through consultation with appropriate resource agencies and stakeholders. In some instances, actual ecological studies or other types of in-field data collection efforts may be required to collect additional data.

The need for, as well as the type and scale of, project impact assessments will vary by site and will be highly device and site-specific. During the environmental permitting process for each project, it is expected that resource agency staff, other stakeholders, and developers will discuss concerns regarding potential project effects, project operation characteristics, and how effects can be avoided or minimized. Through this consultation process, project stakeholders may determine that certain post-deployment field studies are appropriate to assess project operation effects given the lack of environmental studies related to these new technologies.

2.5 Avoidance/Mitigation

The development of tidal energy projects has the potential to utilize ocean resources to generate clean, renewable energy with minimal environmental effects in comparison to other energy generating methods. One of the primary goals in developing a TISEC project is to avoid negative effects to the environment. Depending on the environmental issues identified at each site, and the regulatory requirements, mitigation may be warranted. Many potential conflicts, including other uses such as recreational use, commercial shipping, and commercial fishing, can be identified and avoided through early dialogue during the site selection process (EPRI 2004).

■ **Mechanical or Flow-Related Injuries**

As indicated above in Section 2.2.2.1, there is little information as to whether, and if so, to what degree, tidal turbines cause mechanical and flow-related injuries to fish, marine mammals, diving birds, or other aquatic life. Verdant is planning to conduct a hydroacoustic field study to assess these potential effects for their turbine for the RITE Project. Different tidal technologies likely represent varying potential for mechanical or flow-related injuries to marine fauna.

Careful planning and siting of a TISEC project can help minimize the potential for these types of effects. For example, heavily used seal haul outs should be identified during the site selection process. By not locating a project near such an area can help minimize the potential for project effects resulting from mechanical or flow-related injuries. It may also be appropriate to avoid development near seabird nesting areas, if activities associated with maintaining the project, especially a commercial scale development, are expected to represent a significant disturbance.

■ **Entanglement/Entrapment**

Project operation should be evaluated for the potential for entanglement or entrapment of marine mammals, seabirds, and other marine life. This potential should be assessed in relation to design, operation, critical seasons, and siting of the proposed project (EMEC 2005). Where the transmission cable is anchored to the seafloor, it should be deployed in such a way as to provide maximum contour to the seafloor to minimize spaces where marine mammals could become trapped.

■ **Potential Habitat Effects**

Knowledge of the marine life that uses the area, and how and when they use the area, will be important for proper siting and for minimizing effects to the project area marine community from the construction and operation activities. Above water features of tidal projects can be developed to prevent use for seabird nesting and pinniped haul-out. In the event that precluding use of above-water components of the projects by sea birds and marine life is not of primary importance, if appropriate, decommissioning of a facility could be done in phases or as other projects are being constructed to ensure that pinniped and sea bird populations can gradually adjust to any reduction of habitat (EPRI 2004).

Many construction and decommissioning effects can be avoided or minimized by conducting activities during calmer summer months and during periods that avoid any sensitive timeframes (certain spawning or migration periods). Project siting should occur so as to avoid sensitive habitats and to minimize potential effects to the marine community. Sensitive habitats may include areas of management or conservation focus, such as habitat important to threatened and endangered species, kelp beds, and submerged aquatic vegetation (e.g., eel grass). These areas should be identified early in the siting process and avoided if possible. Also, projects should be sited so as to avoid sensitive or commercially important habitats such as licensed shellfish areas. HDD can be used instead of open trenching to minimize effects to the seabed and intertidal zone during laying of transmission cables. To minimize potential for frac out (escape of HDD drilling fluids from the HDD conduit to the seabed), the HDD contractor should adhere to best practice standards. Important precautions include providing adequate depth of cover during the HDD and analyzing the subsurface material and the depth of cover material along the cable route. Typically, cohesive soils, such as clays, dense sands, and competent rock are considered ideal materials for HDD.

By locating the TISEC units on hard substrates, especially bedrock and boulder, re-suspension of sediments and scour can be avoided. If scour is a concern around project pilings or structures, scour protection measures can be taken. Scour protection can be achieved by installing special scour control mats or dumping large rocks around foundations (Previsic and Bedard 2005). Scour protection processes are well known, though their application is site specific (Bedard et al. 2005). The pilings proposed for the Cape Wind Energy Project were designed to trap sediments and become buried and provide suitable habitat for colonization by benthic organisms.

The extraction of tidal energy may potentially affect the environment. This would depend on site characteristics and the type and number of tidal energy units. For the commercial-scale project, EPRI is planning to withdraw no more than 15 percent of the tidal energy at any site and expects that no negative effects to the environment will result.

During decommissioning, it may be beneficial to evaluate whether less damage may result if fixed structures are left in place on the seafloor.

Potential effects of electric fields from underwater transmission cables can be eliminated by adequate shielding of the cable system. USACE (2004) stated that potential noise effects associated with pile driving can be minimized by employing a "soft start" in order to allow fish to migrate away from the pile driving area.

■ **Water Quality**

During construction and operation, appropriate procedures should be established to identify and prepare for potential spillage of any materials that may damage the aquatic community. Appropriate choice of chemicals and adequate sealing will also help minimize potential for leaks from the units (ABPmer 2005). Through proper construction and installation of the units using best practices, the risk leakage of lubricants, antifoulant contamination, or from other chemicals should be controllable (Coutant and Cada 2005).

During decommissioning, project structures that are removed should be disposed of promptly (not left on shore for extended periods of times), working fluids and plant components should be removed in compliance with appropriate industry regulations. Any project components that are left on site to serve as artificial reefs should be properly cleaned (EPRI 2004).

■ **Marine Uses**

Because tidal projects can represent navigation obstacles, a developer should consult with the U.S. or Canadian Coast Guard and appropriate state and provincial agencies to minimize effects to navigation. This is important to minimize effects on shipping lanes, harbor entrances, and other areas of heavy boating use. For projects involving multiple TISEC units, the devices can be configured so as to minimize obstruction of shipping lanes. For example, units can be arranged in a single line or a couple rows parallel with the flow so as to minimize obstruction of navigation lanes. Creating boating exclusion zones (safety zones) and the use of navigation lights and radar reflectors will minimize the risk of collision. Depending on site conditions and project characteristics, sound signals may also be required (EPRI 2004). High contrast day-markers will help ensure visibility to boaters during the day. EPRI (2004) reports "The U.S. Coast Guard specifies that such markers be in the form of a diamond-shaped sign, 3 feet by 3 feet (0.9 m on a side), with black lettering on a white background and an orange reflective border". If communications are to be sent from the device to shore, care should be taken to ensure that it won't disrupt normal shipping communications. Any restrictions necessary for boating safety should be implemented in coordination with the USCG. Coordination with the USCG and local Harbor Pilots during the design, construction, operation, and maintenance of the project can aid in ensuring public safety.

If the tidal project is located far from shore, effects to commercial and recreational fishing can be minimized by burying the transmission cable to a sufficient depth, thus precluding the need for a fishing exclusion zone along the cable route. By consulting with appropriate agencies and stakeholders during project siting, construction, and operation, a developer can work to minimize potential effects associated with the project. Also, during information about construction activities and schedule can be publicized to notify fishermen in advance of project construction or maintenance activities. Project location, especially exclusion zones, should be publicized and included in appropriate navigation charts.

■ Terrestrial Habitat

Careful siting of land portions of the project should include identification and avoidance (to the greatest extent practicable) of any wetlands, and protected terrestrial and freshwater species and their habitat. Use of existing transportation and utility corridors should be used when possible to minimize effects of project access roads, additional vegetation clearing, and onshore transmission lines. As previously stated, permanent cover type conversions may occur to forested areas from construction of the shore station, access roads, parking area, or transmission ROW. Restoration of any affected wetlands can be expedited by minimizing the duration of work required for pole installation within wetland areas. During construction of the ROW, removal of stumps in wetlands will typically not be required unless personnel safety requires it.

The general measures that should be utilized to minimize effects to wetlands along the transmission line ROW include the following protective measures:

- Sediment/erosion control devices should be installed across the ROW on any slopes leading into wetlands and along the edge of the construction area, as necessary, to prevent disturbed soils from flowing into wetlands or off the ROW into a wetland.

- Construction equipment operating within wetlands should be limited primarily to those needed to clear the area, drill the hole necessary for pole structures, set the pole structures, and restore the affected area.
- To minimize disturbance and compaction in wetlands with saturated soils or standing water, either wide-tracked or balloon-tired equipment operating from timber corduroy or timber mats should be used. In addition, performing the majority of construction within wetlands during winter months when soils are more stable and/or frozen is another minimization measure that can be used to reduce wetland effects.

■ **Aesthetics**

Any visual effects can be minimized by working to blend structures with the landscape. This may include, if possible, painting above-water portion of the project in colors that blend in with the surroundings and limiting the scale of and landscaping the terrestrial buildings to blend with the local flora. It may, however, be determined that above water structures should be painted in highly visible patterns for navigation safety.

■ **Cultural and Historical Properties**

During the siting process, consultation with the state preservation office and any area Indian tribes may help identify any historic or cultural resources in the area.

Section 3
Permitting Issues

The regulatory permitting and licensing processes associated with a TISEC project located in either the U.S. or Canada can be quite involved and complex. The discussions in the subsections below are intended to identify the various federal, provincial, and state (Massachusetts, Maine, New Brunswick, and Nova Scotia only) licenses, permits, and respective jurisdictional authorities that a developer should be knowledgeable of in the planning phases of a TISEC project.

3.1 U.S. Federal Permitting Requirements

Outlined below are the federal permitting activities related to the deployment and operation of a TISEC project in U.S. jurisdictional waters.

Federal Energy Regulatory Commission License

Since 1920, the United States Federal government has asserted jurisdiction as lead agency over the nation's hydroelectric projects. Construction and operation of non-federal hydroelectric projects in the United States requires a license under the Federal Energy Regulatory Commission (FERC), in accordance with Section 23(b) of the Federal Power Act (FPA) 16 U.S.C. 817(1). This requirement, which has been thoroughly established by relevant statutes and regulations, has been used to strictly affirm FERC's jurisdiction and exclusive authority to license non-federal hydropower projects located on navigable waterways of the U.S. FERC regulates the development and operation of hydroelectric generating facilities with both preliminary permits and licenses.

Recently, through legal interpretation from FERC, the requirement that construction and operation of non-federal hydroelectric projects in the United States requires a FERC license has been used to bring unconventional tidal and wave energy hydroelectric projects under FERC jurisdiction (AquaEnergy Group, Ltd. 2003, 101 FERC 62,009). At this time, it appears most in-stream tidal energy conversion facilities will be found to be FERC-jurisdictional and will be required to obtain a FERC license prior to construction and subsequent operation. However, as shown by Verdant's RITE Project and based on the FERC Declaratory Order of April 14, 2005, a project may be relieved of FERC licensing obligations for testing purposes if: 1) the technology in question is experimental; 2) the proposed facilities are to be utilized for a short period for the purpose of conducting studies necessary to prepare a license application; and 3) power generated from the test project will not be transmitted into, or displace power from, the national electric energy grid[20]. Based on these requirements, Verdant did not meet the third criterion and modified their request to FERC by asserting that the induction generators cannot be tested unless they are connected to the grid to generate electricity. In a subsequent request, Verdant offered to provide power at no charge and compensate the entities for the power that would otherwise be sold, resulting in no net economic impact to these entities or on interstate commerce. The July 27, 2005 FERC Order granted Verdant's request to test turbines in accordance with these proposed terms. Other turbine technologies may not require grid connection in order to be tested, hence meeting the criteria specified above. However, for the purposes of this feasibility study, whereby one of the objectives is to connect the turbine to the grid, compensation to the entities for power that would otherwise be sold, may be required unless future FERC decisions dictate otherwise.

- **FERC Preliminary Permit**

The purpose of a preliminary permit is to reserve a site for up to 36 months while a potential developer performs the necessary consultation and study (engineering and environmental) activities necessary to prepare a license application to obtain a FERC license. In context of Part I of the FPA, a preliminary permit secures the priority for an application for a license for a water power project while the permittee conducts the activities necessary to prepare an application for a license during its 36-month term [18 CFR 4.80]. In effect, a developer that obtains a preliminary permit secures preference of application before the Commission so that if another developer files a competing application — provided both are equal in terms of their plans to develop, conserve, and utilize the water resources of the region — the original preliminary permit holder will be granted a license over a competing application.

In order to obtain a preliminary permit, a developer must submit an application to FERC. The application is then noticed by FERC in support of a 60-day public comment period, during which each applicable regulatory agency (e.g., the state's environmental authority) is made aware of the requested permit. Based on a series of criteria (e.g., conflict with existing FERC licensed facilities) and comments received, FERC will either issue or deny a preliminary permit based on the merit of

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20 *See* Verdant Power LLC: Declaratory Order, 111 FERC 61,024 (2005).

the proposal. Upon issuance of a preliminary permit, FERC assigns the project a FERC project number, which allows for tracking of the project by FERC and project stakeholders.

Preliminary permits have a maximum term of 36 months and may be issued with conditions (e.g., submittal of six-month status reports and consultation with commenting parties to address concerns raised during the public notice period). If an application for license is not submitted to FERC within this 36-month term, the permit expires. Upon expiration of the permit, the developer can file for a new 36-month permit; however, the developer and FERC must follow the same process as associated with the initial permit (e.g., submittal of an application and public notice period). In addition, similar to the initial permit process, FERC will evaluate any competing preliminary permit applications or license applications that may be submitted at this time. Upon issuance of a new preliminary permit, FERC will assign the project with a new FERC project number.

FERC's recent decision on the RITE project with regard to deferral of licensing obligations for testing purposes, is consistent with the intent of FERC's preliminary permit program that allows a potential licensee to conduct the tests necessary to determine the technical and economic feasibility of applying for the necessary permits and licenses required by statute to develop and operate in-stream tidal and ocean energy projects.

■ **FERC License**

A FERC license, which as defined by the FPA must have a term of 30 to 50 years, is the approval necessary to develop and operate a hydroelectric project in the U.S. The term of the license is dependent upon the amount of redevelopment, new construction, new capacity, or environmental mitigation and enhancement measures authorized or required under the license[21]. Original licenses (i.e., licenses for new projects) are typically issued for 50-year terms.

The FPA provides the Commission with the authority to approve and monitor hydroelectric projects in the U.S. In addition, the FPA provides the requirements for which all hydroelectric projects and licensing activities must meet. The following provides an example of a few of the major statutory requirements (e.g., mandatory conditioning authorities) associated with the FPA. These examples

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[21] *See* Georgia Power Company: Order Denying Rehearing and On Clarification, 111 FERC 61,183 (2005).

provide some insight into the potential role of other federal agencies during the licensing process, as well as other requirements (e.g., comprehensive plans) that a developer must address.

- **Section 4(e)**, which applies to projects on federally reserved lands, authorizes federal land management agencies (e.g., U.S. Forest Service) to include mandatory conditions in the FERC license that aim to protect the land under its jurisdiction for its primary intended use.
- **Section 10(a)** requires that any project for which the Commission issues a license shall be best adapted to any applicable comprehensive plan for: 1) improving or developing a waterway for the use or benefit of interstate or foreign commerce; 2) the improvement and utilization of waterpower development; 3) the adequate protection, mitigation, and enhancement of fish and wildlife; and 4) other beneficial public uses, including irrigation, flood control, water supply, and recreational purposes.
- **Section 10(j)** requires that each hydropower license include conditions for the protection, mitigation, and enhancement of fish and wildlife and their habitats that are to be based on recommendations by the NMFS, the USFWS, and appropriate state fish and wildlife resource agencies, as long as they are consistent with purposes and requirements of the FPA.
- **Section 18** allows both the Secretary of Interior (through the USFWS) and the Secretary of Commerce (through the NMFS) to require the construction, operation, and maintenance of fishways as part of a FERC license.

■ Integrated Licensing Process

Given FERC's interest in promoting use of their new Integrated Licensing Process (ILP), the following discussion focuses on this new process and makes comparisons to FERC's other two processes, the Traditional Licensing Process (TLP) and the Alternative Licensing Process (ALP). Please note, the following discussion is not intended as a full description of the licensing process, but a summary of a variety of key components.

As of July 23, 2005, the ILP has become the default licensing process for developers and hydroelectric facility owners seeking a FERC license. In addition to the ILP, FERC maintains two other non-default licensing processes: the TLP and the ALP. The TLP or the ALP may be utilized in lieu of the ILP, however, only by request submitted to and approved by the Commission. According to regulations, these requests may only be granted with "good cause" shown by the applicant[22].

FERC developed the ILP to provide "a predictable, efficient, and timely licensing process" that "continues to ensure appropriate resource protection."[23] Stressing the fundamentals of early study plan development, better coordination with other stakeholder processes, and established timeframes[24], the ILP is intended to improve upon some of the recognized shortcomings of the TLP and ALP through the following measures:

- Upfront National Environmental Policy Act (NEPA) scoping;
- Increased public participation in pre-filing consultation;
- Development by the applicant of a Commission-approved study plan;
- Increased coordination between the Commission's and other agencies' processes; and
- Encouragement of informal resolution of study disagreements followed by a formal dispute resolution early in the consultation process[25].

The ILP establishes a procedural framework for agency, stakeholder, and tribal consultation with both the applicant and the Commission, which is meant to achieve consensus over study plans that are ultimately included in a license application. As compared to the TLP and ALP, the ILP has been regarded as a "front-end loaded" process, with its first year of activity being relatively involved. This additional initial activity is intended to deal with identified issues in an upfront manner (i.e., during the study scoping process), rather than trying to address such issues in the later stages of the licensing process (e.g., following submittal of the application to FERC).

An important goal of the ILP is to establish agreement among project stakeholders regarding the licensing study plan. The study plan is a key component of the ILP and details the need and methodology for the studies necessary for development of the final license application. The study plan is developed through consultation (e.g., meetings) with a variety of project stakeholders. Studies or study requests may be initiated by either the project applicant (i.e., developer) or project

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22 *See* 18 CFR 5.3(e).

23 FERC - Implementing the Integrated Licensing Process: Regional Training and Effectiveness Workshop. June 7, 2005: Albany, New York.

24 *See* previous.

25 *See* http://www.ferc.gov/industries/hydropower/indus-act/ilp/over.asp.

stakeholders (e.g., agency or non-governmental organizations [NGOs] representatives). Under the ILP, FERC has established seven criteria by which an applicant (and potentially FERC) evaluates a study request made by a project stakeholder. According to these regulations (18 CFR 5.9(b)), a study request must:

1. Describe the goals and objectives of each study proposal and the information to be obtained;
2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;
3. If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study;
4. Describe existing information concerning the subject of the study proposal, and the need for additional information;
5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements;
6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and the duration) is consistent with generally-accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge; and
7. Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

If a study plan is not mutually agreed upon, a federal agency, state agency, or an Indian tribe with mandatory conditioning authority may request that a study dispute be referred to a dispute resolution panel, which would consist of FERC Office of Energy Projects staff, a representative from the agency or tribe referring dispute to the Commission, and a third party from the panel member list selected by the other two panelists.

USACE Permits

The USACE evaluates essentially all construction activities that occur in the Nation's waters, including wetlands, by two primary legislative vehicles: Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. As it relates to hydroelectric projects, Section 404 permits come in three forms: 1) nationwide general; 2) regional general; and 3) individual. National and regional general permits cover activities that are similar in nature and have been determined to cause only minimal individual and cumulative environmental impacts. Individual permits cover more unique projects and are issued following a case-by-case evaluation of a specific structure or work. Given that issuance of a permit by the USACE is a federal action, prior to issuing a permit, the USACE must conduct a NEPA review of the proposed project. Such a review (e.g., Environmental Assessment) is often transparent to the applicant; however, such a process does include a public notice period and could lead to a more involved Environmental Impact Statement process if deemed necessary by the USACE.

To date, it has been the experience of multiple developers that until FERC becomes engaged in the licensing process (e.g., submittal of the license application under the TLP), the USACE often takes the lead federal role in the permitting of test units in support of FERC license applications. Therefore, depending on the studies to be performed, the USACE may have a considerable role in the deployment process.

- **Section 10 of the Rivers and Harbors Act of 1899**

Section 10 of the Rivers and Harbor Act of 1899 (33 U.S.C. 403) gives the USACE jurisdiction and authority over the protection of navigable waters. Therefore, any construction, excavation, or deposition of materials in, over, or under such waters, or any work that would affect the course, location, condition, or capacity of those waters is subject to the USACE permitting authority. To ensure that any obstruction or alteration of any navigable water of the U.S. does not adversely affect the navigable properties of the waterway, the USACE is required to review all work or the placement of structures in or affecting navigable waters of the U.S., including the construction of TISEC facilities.

- **Section 404 of the Clean Water Act**

Pursuant to Section 404 of the Clean Water Act (33 U.S.C. 1344), the USACE must review all proposals for the discharge of dredged or fill material into waters of the U.S. Under this section, the phrase "discharge of dredged or fill material into waters of the United States" includes any physical alternation including, but not limited to streambed disturbance or installing pilings. In addition, “waters of the United States” includes, but is not limited to tidal straights, coastal waters, estuaries, inland rivers, lakes, streams, and wetlands.

In general, Section 404 permits are evaluated on:

- The potential effects on environmental aspects associated with the project and surrounding area;
- The relevant extent of public and private needs;
- Where conflicts exist, the practicability of using reasonable alternative locations and methods to accomplish project purposes; and
- The extent and permanence of the effects the proposed project may have on public and private uses to which the land is suited.

Section 401 of the Clean Water Act Section 401 - Water Quality Certificate

In accordance with Section 401 of the Clean Water Act, any activity requiring a federal action (e.g., license or permit) that may result in a discharge into navigable waters is required to obtain certification from the applicable state(s) that any such discharge will comply with water quality standards contained with the Clean Water Act. Therefore, a TISEC facility will require a section 401 Water Quality Certificate (WQC) in support of their USACE permit (i.e., Section 404 permit) and/or FERC license. From the time a Section 401 application is submitted to the state permitting authority (e.g., Department of Environmental Protection), the agency has up to one year to issue or deny the WQC.

Endangered Species Act

The ESA of 1973 provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend through federal action. The ESA demands that civil and criminal penalties are assessed on anyone found taking, possessing, selling, or transporting an endangered or threatened species in an unauthorized manner. “Take” is defined by the ESA as: “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.”

Section 7 of the ESA requires federal agencies to ensure that their activities (permitting or licensing) will not jeopardize the continued existence of listed species or adversely modify designated critical habitats. The federal agencies responsible for the protection of listed species are the USFWS for inland species and NOAA Fisheries for marine species. In most cases, NOAA Fisheries would be the federal agency responsible for coastal species that might occur within tidal project areas; however, on the east coast, NOAA Fisheries and the USFWS share responsibility for diadromous fish species. Anyone applying for a federal permit, such as USACE Section 10 or 404 permits for a demonstration project, or a FERC license, must first determine whether their project will have any impacts to endangered or threatened species. While the final responsibility is between the consulting federal agencies, it is incumbent on the applicant to provide the necessary information to the lead federal agency (e.g., the USACE or FERC).

If it is determined that listed species may occur in the action area (the project's action area can vary widely depending on the type of project), then a determination of project effect must be made. If the federal action agency (USACE or FERC) determines that the proposed action (project permitting) will have no effect on the species or critical habitat and NOAA Fisheries concurs, then no consultation is necessary. If the federal action agency determines the proposed action "may affect" listed species or critical habitat, then Section 7 consultation is required. Again, it is generally the applicant or their representative who compiles all the information and provides it to the action agency. The applicant can request to be designated a non-federal representative which will allow them to consult directly with NOAA Fisheries during this informal consultation stage. It is highly recommended that the applicant, once designated as the non-federal representative, keep in close contact with NOAA Fisheries to identify the most relevant and useful information on species status and potential effects, resolve any project conflicts or differences of opinion on what constitutes adverse effect, and to identify potential measures to avoid or minimize any potential effects. One potential complication to this process is that if very limited information is available to determine the presence of protected species in the project area, NOAA Fisheries may request additional studies to evaluate species presence in the action area. If the species may only be present seasonally, this can extend the informal consultation process substantially; especially if a Section 10 research permit is required (see below).

Once all the relevant information has been obtained, it is generally compiled in the form of a Biological Assessment (BA). There is no prescribed timeline for informal consultation except for some individual elements such as the BA must be submitted within 180 days of receiving a species list from NOAA Fisheries. This is to ensure that an accurate and up-to-date species list is being used. The BA must determine if the project has no effect or is likely or not likely to adversely affect any protected species evaluated. The BA is submitted to NOAA Fisheries for review and concurrence.

If, based on the information provided, NOAA Fisheries finds that the proposed action “may affect” but is “not likely to adversely affect,” NOAA Fisheries will provide a concurrence letter and consultation is complete. If the federal action agency or NOAA Fisheries determines that the project is “likely to adversely affect,” then formal consultation is required. NOAA Fisheries must develop a Biological Opinion (BO) which describes the environmental baseline and expected project effects. In most cases, the BO will include an Incidental Take Statement (ITS) and Reasonable and Prudent Measures (RPM) to minimize or avoid project effects. The ITS allows the project to move forward only if all RPMs are followed. These measures are generally written in as permit or license conditions. Additional studies or monitoring may also be required, especially in cases where project effects are not clearly defined. This may often be the case for many tidal energy technologies that do not have baseline information on environmental effects. The ITS protects the permittee from potential judicial action should any harm to protected species result from the project.

In very rare cases, a finding of “likely to jeopardize proposed species/adversely modify proposed critical habitat” may result. This can only result when the project has the potential to jeopardize the species existence such as may occur for species with very limited distribution. This is highly unlikely in coastal ocean environments.

It is important to note that additional ESA permits may be required. Should any biological or other environmental survey work be conducted in an area where endangered or threatened species may occur, a Section 10 permit will likely be required. There are two types of such permits, Section 10(a)(1)(A) is scientific research permit where listed species are the target of the research and “take” may occur. A Section 10(a)(1)(B) permit (Incidental Take Permit) is needed if you are engaged in an otherwise lawful activity where a listed species may be adversely affect, and the purpose of your activity is not scientific research or enhancement of listed species. For example, trawling surveys to determine fish distribution and abundance that may inadvertently harm a protected marine turtle would require an Incidental Take Permit. Consultation with NOAA Fisheries should be conducted to determine the need for either of these permits before studies are conducted. It can be a lengthy process to obtain a Section 10 permit so it is advisable to determine if one would be necessary early in the permitting process.

Marine Mammal Protection Act

The MMPA of 1972 places responsibility with the NOAA Fisheries and the USFWS to conserve marine mammals and establishes a moratorium on the taking of marine mammals in the U.S. and its territorial waters. NOAA Fisheries specifically manages cetaceans (whales and dolphins), seals, and sea lions. The USFWS manages walruses, sea otters, manatees, and polar bears.

Any person who plans to incidentally "take" or "harass" marine mammals must obtain a permit from NOAA Fisheries or the USFWS to perform such activities[26]. Note that the definition of "harass" is often used rather broadly. Incidental Taking Authorizations, also referred to as Letters of Authorization (LOA), are generally issued within six to eight months. Incidental Harassment Authorizations (IHA), which are generally applied to instances of visual or acoustic harassment, are issued within 120 days.

Migratory Bird Protection Act and Bald and Golden Eagle Protection Act

The Migratory Bird Protection Act (MBPA) of 1918 implements the U.S.' commitment to treaties with Canada, Mexico, Japan, and Russia for the protection of a shared migratory bird resource. The original treaty addressed the protection of migratory birds meaning "the many species of birds that traverse certain parts of the U.S. and Canada in their annual migration" and to stop the "indiscriminate slaughter" of migratory birds by market hunters and others.

Each of the four treaties (with the individual countries) protects selected species of birds within the U.S. and provides for closed and open seasons for hunting game birds. The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or

26 *See* http://www.nmfs.noaa.gov/pr/permits/faq_mmpermits.htm.

transport any migratory bird, or any part, nest, or egg or any such bird. Any permits to do so are merely for scientific and educational purposes.

Magnuson - Stevens Fishery Conservation and Management Act

The Magnuson - Stevens Fishery Conservation and Management Act establishes exclusive U.S. management authority over all fishing within the exclusive economic zone (i.e., 200 nautical miles from shore) for all anadromous fish throughout their migratory range. The Act establishes eight Regional Fishery Management Councils responsible for the preparation of fishery management plans that aim to conserve and manage fishery resources in waters of the U.S.

NOAA Fisheries, has been charged with implementation of the Act and is responsible for overseeing the fishery management plans. As such, a TISEC facility must be deployed and operated in a manner consistent with such plans.

National Historic Preservation Act, Section 106

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to consider the effects of project deployment and operations on properties listed or eligible for listing on the National Register of Historic Places. This requirement translates to mean that any proposed project must consider options to avoid, minimize, and mitigate adverse impacts to historical properties. Compliance with Section 106 of the Act often requires consultation with the state's Historic Preservation Office and possibly Native Indian Tribes currently or historically associated with the proposed project area. Section 106 requires the lead federal agency to document the consultation process, describe the anticipated effects to historic properties, how these issues were considered in permitting the proposed project, and to offer the Advisory Council on Historic Preservation the opportunity to comment on their conclusions and recommendations.

U.S. Coast Guard Aids to Navigation

Structures located in the waters of the U.S. and its territories that may interfere with or restrict marine navigation are to be marked to assist navigation by the U.S. Aids to Navigation System. This system employs an arrangement of colors, shapes, numbers and light characteristics to mark navigable channels, waterways, and obstructions. In order to establish and maintain a privately-owned aid to navigation, the operator must apply to the Commander of the Coast Guard District in which the aid is or will be located for approval. Specific information to be included in the application can be found at 33 CFR 66.01-5.

International Joint Commission Coordination

The International Joint Commission (IJC) prevents and resolves disputes between the U.S. and Canada under the 1909 Boundary Waters Treaty and pursues the common good of both countries as an independent and objective advisor to the two governments. For projects next to an international boundary, a developer should consult with the USACE as to whether the project construction, operation, or maintenance would affect Canadian waters and consequently, whether IJC coordination is needed (pers. comm. Jay Clement, USACE, March 7, 2006).

National Pollutant Discharge Elimination System

The Clean Water Act of 1972 emphasized controlling pollutant discharges from industrial sources through the National Pollutant Discharge Elimination System (NPDES) permit program. The NPDES permit program requires that every industrial or municipal "point source" discharging into public waters obtain an NPDES (or a state equivalent permit for delegated states). Such permits specify numerical discharge limits for a wide range of individual substances and require detailed self-monitoring.

Discharge limits in permits are expressed as average and maximum pollutant levels which can be achieved by using the best available technology (BAT) economically achievable. If this treatment level does not protect local water uses, more stringent standards may be applied. Published treatment standards (effluent guidelines) and national technical guidance are used by states and local sewer authorities to assure uniformity.

Although a NPDES permit may be required for deployment and operation of a TISEC facility, it is more likely that any discharges associated with a facility will be regulated through a Section 401 WQC or Section 404 permit.

Minerals Management Service

Projects located greater than three nautical miles (nm) (i.e., seaward of the state's submerged lands) from shore must acquire a federal lease, easement, or ROW to develop on the Outer Continental Shelf (OCS). Section 388 of The Energy Policy Act of 2005, signed into law by President George W. Bush on August 8, 2005, authorized the Department of Interior through the MMS to grant these leases, easements or rights-of-way on the OCS for the development and support of renewable energy projects including wave/tidal, wind, or solar energy on the OCS. The MMS is required to issue regulations for carrying out its new authority by mid-May 2006.

Under this new authority, MMS will become the lead federal agency for permitting and regulatory oversight of any projects located within the OCS currently being reviewed by the USACE. TISEC projects are not anticipated to be installed in waters that are located more than three nautical miles offshore, therefore developers of these projects may not need to consider MMS authorization. However, the USACE will continue to play a role in the permitting process pursuant to its authority under Section 10 of the Rivers and Harbors Act.

A summary of relevant U.S. federal permits, license, and respective agencies for TISEC projects are listed in Table 3-1.

TABLE 3-1
U.S. FEDERAL PERMITS, LICENSES AND RESPECTIVE AGENCIES FOR A TISEC PROJECT

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
FERC Preliminary Permit	FERC	Secures priority of application for a license for a water power project while the permittee obtains data and performs acts required to determine the feasibility of the project and to support a license application.	Approximately four months
FERC License	FERC	Authorizes operation of hydroelectric projects that are located on a navigable waterway of the U.S. for license terms between 30 and 50 years. Temporary, experimental projects that are isolated from national grid may be relieved of licensing requirements.	5 to 7 years

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
Section 10 Rivers & Harbors Act	USACE	Regulates structures and/or work in or affecting navigable waters of the U.S., including the construction of permanent structures; review is concurrent with Section 404 review. Section 10 review includes ESA Section 7 consultation.	3 to 36 months
Section 404 Dredge/Fill permit	USACE	Regulates discharge of dredged or fill material into the navigable waters at specified sites; review is concurrent with Section 10 review.	3 to 36 months
Section 401 Water Quality Certificate	USACE and/or FERC	Sets guidelines for activities affecting the water quality in order to maintain minimum water quality standards.	12 months
Endangered Species Act	USFWS, NOAA	Provides for the protection of threatened and endangered species of fish, wildlife, and plants and designated critical habitat.	n/a
Marine Mammal Protection Act	USFWS, NOAA	Prohibits the taking of marine mammals in the U.S. and its territorial waters; incidental take or harassment permits may be granted.	6 to 8 months for incidental take; 120 days for incidental harassment.
Migratory Bird Treaty Act	USFWS	Prohibits the harming of migratory birds, listed at 50 CFR 10.13. No permit program is in place to authorize the incidental taking of a listed migratory bird.	n/a
Magnuson - Stevens Fishery Conservation and Management Act	NOAA	A TISEC facility must not be constructed in conflict with fishery management plans.	n/a
NPDES	USEPA	Protects water quality by regulating point source discharges into a public body of water. Permit requirement is applied to commercial and industrial entities.	3 to 12 months
Section 106 National Historic Preservation Act	USACE	Requires federal agencies to “take into account” the effects of project siting on properties listed or eligible for listing on the National Register of Historic Places. Lead federal agency must document how options that avoid, minimize, and mitigate adverse impacts to historical properties were considered in approving the project.	n/a
Coast Guard Regulations - hazards to navigation	USCG	Aids to navigation placed on structures in the waters of the U.S. must be approved by the USCG and must follow established marking standards.	n/a
Authorization for use of OCS lands	MMS	Depending on plant location, a lease, easement or ROW may be required to house facilities on OCS lands (i.e., greater than 3 nm from coastline). At a minimum, land lease would be required for transmission lines to shore. Also, under the FPA, the licensee has power of eminent domain which could possibly be used to acquire state lands (i.e., less than 3 nm from coastline).	n/a

3.2 Canadian Federal Permitting Requirements

Outlined below are the federal permitting activities related to he deployment and operation of a TISEC project in Canada's jurisdictional waters. Unlike in the U.S., where a fully-operational tidal or wave project has not been deployed or operated for an extended period of time, in Canada, the 20 MW Tidal Energy Annapolis Royal Project was installed in Nova Scotia in 1984 and continues to operate today. The regulatory history of this facility provides some insight into the permitting process for such developments in Canada; however, due to the fundamental difference in operation between the Annapolis Royal Project and the TISEC projects presented in this report, it is possible that some of the existing regulations which refer to a "tidal project," may not apply in their entirety to a TISEC project. The Annapolis Royal Project incorporates a barrage and operates under the principal of differential water elevations to force water through a hydropower turbine, which is a different principal of operation when compared to a TISEC project. The potential environmental effects associated with a TISEC project, whereupon the water is allowed to flow freely around the turbine, may vary significantly to those associated with the Annapolis Royal Project.

Also as compared to the U.S., Canada does not have a single federal agency like FERC that oversees (i.e., serves as the lead federal agency for) all hydroelectric power licensing and compliance activities. Comparatively, the deployment and operation of such facilities in Canada are approved and monitored by a series of federal and provincial environmental agencies and associated laws. The following describes the primary federal environmental laws applicable to TISEC facilities in Canada and where applicable, the agencies with jurisdictional authority.

Canadian Environmental Assessment Act

The Canadian Environmental Assessment Act (CEAA) is the legal basis for the federal environmental assessment process and establishes the responsibilities and procedures for carrying out the environmental assessments of projects which involve federal government decision making. An environmental assessment is a process to predict the environmental effects of proposed initiatives before they are carried out. The purpose of an environmental assessment is to:

- Identify the possible environmental effects;
- Propose measures to mitigate adverse effects; and

- Predict whether there will be significant adverse environmental effects, even after the mitigation is implemented.

An environmental assessment is required for a TISEC project due to the federal approval processes involved. For a more thorough review of CEAA applicability, a developer should answer four questions in the following sequence:

1. **Is there a project?** - In the CEAA, projects are defined as either an undertaking in relation to a physical work or an activity listed on the Inclusion List Regulations (SOR/94-637). A TISEC project is a "project" because it is an undertaking related to a physical work.
2. **Is the project excluded?** - A thorough review of the Exclusion List Regulations (SOR/94-639) is warranted to determine if the project is excluded. For reference, based on a review of the exclusion list relative to the TISEC technologies presented in this report, no such exclusions from the environmental assessment process exist at this time. However, technology and site-specific review must be performed as part of the approval and permitting process.
3. **Is there federal authority?** - This term refers to a federal body or agency that may have expertise or a mandate relevant to a proposed project including ministers, departments, departmental corporations, and agencies of the Government of Canada. Several federal agencies have expertise and/or mandates relative to a TISEC project.
4. **Is there a trigger?** - Among other criteria, the CEAA will be triggered when a federal authority provides a license, permit, or an approval that is listed in the Law List Regulations and that enables a project to be carried out. Several programs are listed which relate to a TISEC project.

A TISEC project would fall under one of four different types of environmental assessments: screening (including class screenings), comprehensive study, review panel, and mediation. Screenings and comprehensive studies are self-directed by one or more federal authorities. Mediation and assessment by a review panel are conducted independent of government. The four types of environmental assessments are described below.

■ **Screening**

Under the CEAA, most projects will be assessed through screening, which is a systematic, documented assessment of the environmental effects of a proposed project. Screening will determine whether or not the proposed project is federally supported, hence enabling the project to proceed. Specifically, screening will identify the need to:

- mitigate environmental effects;
- modify the project plan; and/or
- carry out further assessment of the environmental effects of the project through mediation or panel review.

Screenings will vary in time, length, and depth of analysis, depending on: 1) the circumstances of the proposed project; 2) the existing environment; and 3) the likely environmental effects. Some screenings may require only a brief review of the available information and a one- to two-page report. Other screenings may be as thorough and rigorous as a comprehensive study.

■ **Class Screening**

The class screening is a special type of screening that can help streamline the environmental assessment of certain projects. A class screening report presents the accumulated knowledge regarding the environmental effects of a given class or type of project and identifies the known measures to mitigate those environmental effects.

A class screening report is considered acceptable for any class of projects where there is a sound knowledge of the environmental effects and appropriate mitigation measures, such as classes of projects that are routine and repetitive. In applying a class screening report to a project, site-specific circumstances and cumulative environmental effects need to be taken into account.

Once approved by the agency, a class screening report can be used as a model in conducting screenings of other projects within the same class.

■ Comprehensive Study

Although the majority of projects covered by the CEAA will undergo an environmental assessment through a screening, some projects will require a more intensive and rigorous assessment of their environmental effects through a comprehensive study. Conducting such a study may eliminate the need for further review by mediation or review panel.

The Comprehensive Study List, established by regulation, addresses those projects that potentially result in significant environmental effects no matter where they are located.

> *Upon review of the list, Part II Electrical Generating Stations and Transmission Lines, a comprehensive study will be required for "The proposed construction, decommissioning or abandonment of a tidal power electrical generating station with a production capacity of 5 MW or more, or an expansion of such a station that would result in an increase in production capacity of more than 35 per cent." (http://laws.justice.gc.ca/en/c-15.2/sor-94-638/66167.html#rid-66223, accessed January 9, 2006).*

Compared to projects that will undergo a screening, projects requiring a comprehensive study are generally large-scale, complex, and environmentally sensitive. The scope and depth of the analysis is often correspondingly greater as well, and may demand highly specialized skills and experience. There may be a need for:

- gathering environmental baseline data;
- commissioning new studies on specific issues;
- considering highly-technical, one-of-a-kind, site-specific mitigation measures; and/or
- extensive public consultation.

Comprehensive studies require an EA decision from the federal Minister of the Environment, as well as compulsory public participation.

■ **Mediation**

Mediation is a voluntary process of negotiation and an appropriate option when the interested parties are willing to participate and a consensus seems possible. It is particularly effective where there are only a few interested parties and the issues are limited in scope and number. Regardless of whether the issues are resolved, the mediator must prepare a report to the responsible authority and the Minister of the Environment, who then makes it public. The mediator's report is taken into consideration before making any decision with regard to the project.

■ **Assessment by a Review Panel**

A review panel is appointed to review and assess a project with likely significant adverse environmental effects. A review panel may also be appointed where public concerns warrant such a review. Only the Minister of the Environment may order an assessment by a review panel. A report is prepared and submitted by the review panel which summarizes its rationale, conclusions and recommendations, and includes a summary of comments received from the public. The responsible authority must take the review panel's report into consideration before making any decision with regard to the project.

Fish Habitat Protection Authorization

The federal Fisheries Act (FA) provides for the protection of fish habitat whereupon no one may carry out any work or undertaking that results in the harmful alteration, disruption, or destruction (HADD) of fish habitat, unless authorized by the Minister of Fisheries and Oceans Canada. Fish habitat is defined as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes." The FA also states that no one is permitted to deposit a harmful substance into water containing fish. Pursuant to the FA, a Section 35 FA authorization is required for works or undertakings in or around water where fish habitat may be negatively affected.

Prior to starting any aspect of the project, the TISEC project should be discussed with local authorities so that they can assist with determining if the project could cause HADD of fish habitat. The sensitivity of the fish habitat in relation to the project may need to be determined. It is likely that constraints may be imposed to reduce or eliminate harmful impacts to fish habitat. Where projects cannot be redesigned or relocated to avoid a HADD, a sub-section 35(2) Fisheries Act Authorization may be required from the DFO (DFO 2006*b*).

When an authorization is required, the application must include plans for mitigating and compensating any loss in the capacity of habitat to produce fish. Submittal of a habitat compensation plan is required. The DFO will review the project proposal and determine whether an authorization can be issued based on the information provided. An authorization contains legally-enforceable conditions which require specific mitigation, compensation, and monitoring activities.

The preferred option is to avoid adversely affecting fish habitat by redesigning the project or relocating to a less sensitive area. If this is possible, a FA Section 35 Authorization may not be required.

Navigable Waters Protection Division Authorization

The Navigable Waters Protection Act (NWPA) includes provisions for the protection of the public right of marine navigation on all navigable waterways of Canada and is administered by Transport Canada. Upon consultation with the Navigable Waters Protection Officer, a developer of a TISEC project is required to submit an application which includes: 1) details regarding the applicant; 2) the nature of the work; 3) other permits obtained; 4) details of property ownership; and 5) drawings and plans of the proposed project. An "approval" issued under the NWPA authorizes the work only in terms of its effect on navigation and it is the developer's responsibility to obtain any other permits that may be required.

For new construction, there are two types of processes which can be followed: the formal approval process and the work assessment process. The formal approval process is followed when the work has the potential to substantially interfere with navigation, and the work assessment process is followed when Transport Canada officials determine that the work does not substantially interfere with navigation.

The formal approval process is usually longer, requiring the developer to complete additional steps, including advertisement of the work and the completion of an environmental assessment in accordance with requirements under the CEAA. During the advertisement and CEAA process, the public will have an opportunity to comment on the project's potential impact on other waterway users and on the environment. The approval received may include conditions which must be followed in order to mitigate certain impacts the work may have on navigation and the environment.

The work assessment process does not require formal advertisement nor an environmental assessment.

Marine Protected Areas

Canada's Oceans Act establishes Marine Protected Areas (MPA) to conserve and protect unique habitats, endangered or threatened marine species and their habitats, commercial and non-commercial fishery resources and their habitats, marine areas of high biodiversity or biological productivity, and any other marine resource or habitat requiring special protection. The sites selected for this TISEC pilot project are not located in an MPA. Currently, there are five marine protected areas:

- **The Eastport Peninsula** - located in Bonavista Bay, Newfoundland.
- **Gilbert Bay** - located approximately 300 km from Happy Valley-Goose Bay on Labrador's southeast coast.
- **Basin Head** - located on the eastern tip of Prince Edward Island, near the town of Souris.
- **The Gully** - located approximately 200 kilometers off Nova Scotia, to the east of Sable Island, on the edge of the Scotian Shelf.
- **The Endeavour Hydrothermal Vents Marine Protected Area** - located 250 kilometers southwest of Vancouver Island.

The Oceans Act enables the government to establish regulations prohibiting classes of activities within an MPA. This power permits the blanket exclusion of activities that would conflict with the purposes of the MPA. Certain activities related to a TISEC project may be prohibited from being deployed and/or operated in a MPA depending on the individual MPA management plan (DFO 2006*c*).

■ Marine Wildlife Areas

A Marine Wildlife Area is a type of marine protected area, under the authority of Environment Canada and administered by the Canadian Wildlife Service (CWS), which is focused on the protection of habitat for wildlife, and in particular migratory birds. Under the Canada Wildlife Act, the CWS may take measures necessary for the protection of any species of non-domesticated animal in danger of extinction or acquire lands for the purposes of wildlife research, conservation, or interpretation. In 1994, the Canada Wildlife Act was amended to allow creation of national wildlife areas out to the 200-nautical-mile limit so as to better address both coastal and offshore marine conservation issues.

The Scott Islands, located on the northern tip of Vancouver Island will be Canada's first-ever Marine Wildlife Area. There may be other marine wildlife areas proposed which are conducive to the installation and operation of a TISEC facility.

■ National Marine Conservation Areas

National Marine Conservation Areas (NMCA) are marine areas managed for sustainable use and containing smaller zones of high protection. They include the seabed, the water column above it, and they may also take in wetlands, estuaries, islands, and other coastal lands.

NMCAs are protected from such activities as ocean dumping, undersea mining, and oil and gas exploration and development. NMCAs are established to represent a marine region and to demonstrate how protection and conservation practices can be harmonized with resource use in marine ecosystems. Their management requires the development of partnerships with regional stakeholders, coastal communities, Aboriginal peoples, provincial or territorial governments, and other federal departments and agencies (Parks Canada 2005).

Currently, there are only two NMCA sites: Fathom Five National Marine Park in Georgian Bay, Ontario, and Saguenay-St. Lawrence Marine Park in Quebec. Other NMCA sites may be proposed in areas conducive to a TISEC facility.

■ Species At Risk Act

The SARA was proclaimed by the Canadian Parliament in June 2003 and was fully implemented in June 2004. The purposes of SARA are "to prevent wildlife species from becoming extinct, to provide for the recovery of wildlife species that are becoming extinct, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened."

As summarized by Irvine et al. (2005), SARA has four major steps:

1. An independent scientific committee (Committee on the Status of Endangered Wildlife in Canada [COSEWIC[27]]) assesses the potential biological risk and designates a status - referred to as the COSEWIC (biological status) list;
2. Federal Cabinet decides, following consideration of socioeconomic implications, which species from the COSEWIC list to add to the legal list of species at risk - referred to as the SARA (legal) list;
3. Legal protection; and
4. Recovery planning and implementation.

SARA applies to federal jurisdiction lands, most freshwater habitats, and marine habitats (Irvine et al. 2005). This Act challenges federal wildlife agencies with management authority for species at risk (i.e., the Canadian Wildlife Service of Environment Canada, Fisheries and Oceans Canada, and Parks Canada), particularly with respect to the identification of critical habitat. Under SARA, it is illegal to kill, harm, harass, capture, or take any individual of a species listed as extirpated, endangered or threatened, or to damage or destroy their critical habitat or residence (Irvine et al. 2005). Critical habitat, as defined in SARA means, "the 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 recover strategy or in an action plan for the species." However, the Minister of Fisheries and Oceans may authorize activities which may affect aquatic specifies if, "Affecting the species is incidental to the

[27] COSEWIC, which for the most part is independent of the government, consists of a voting membership appointed by the Minister of the Environment. Members include: 1) a representative from each provincial and territorial government wildlife agency, three federal agencies (Parks Canada, CWS, and DFO); 2) the National Biosystematics Partnership; 3) three non-jurisdictional representative; 4) the co-chairs for the Aboriginal Traditional Knowledge Subcommittee; and 5) the co-chairs for the Species Specialist Subcommittees that deal with the taxonomic groups.

carrying out of the activity" (Section 73[2]). This allows incidental harm to occur, though, in order to be permitted, the Minister of Fisheries and Oceans must be of the opinion that, for a proposed marine activity, all three of the following pre-conditions are met:

1. All reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
2. All feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals, and;
3. the activity will not jeopardize the survival or recovery of the species (Section 73[3]).

Irvine et al. (2005) report that:

> *A framework has been developed to document procedures to be used to determine under what conditions permits provided for in Section 73 can be issued (DFO 2004). For activities to be permitted under Section 73, this framework states it is necessary and sufficient to demonstrate that the activity will not leave the DU* (Designatable Unit – used to deal with species below the taxonomic species level) *under worse conditions at the end of the permitting period than it was at the start.*

Following the addition of a species to the SARA list, the federal government is required to initiate various steps to protect and facilitate the recovery of the species. Within two years of a species being listed as endangered on the SARA list, a recovery strategy, which is required to be updated every five years, and an action plan must be developed. Recovery strategies for aquatic species listed under SARA are developed by DFO in collaboration with stakeholders. These strategies and plans will identify any habitat considered critical to the survival or recovery of a species, and will outline protective steps to be taken: from education and stewardship initiatives to modifying or restricting development activities, enhancing habitat, or undertaking further scientific research to better understand species and their habitat.

It is the responsibility of a developer to ensure that any project complies with SARA. The process requires that a project must be reviewed by local, provincial, or federal authorities and authorized through formal approvals and permits.

If a species at risk is determined to live within or pass through a project area or if critical habitat exists in the project area, a developer must:

- ensure that any activities (including research, resource exploitation, and/or maintenance) carried out on these lands comply with SARA requirements;
- notify the competent department or agency if a project (as defined in subsection 2(1) of the Canadian Environmental Assessment Act) that requires an assessment of environmental effects is likely to affect a SARA listed species or its critical habitat;
- apply for a permit in advance if a proposed activity could contravene a SARA prohibition;
- take SARA requirements into account when you:
  - sign agreements with contractors or subcontractors working on federal lands;
  - fund activities affecting species at risk; and
  - grant permits or authorizations under legislation other than SARA;
- provide your partners with accurate and reliable information on the Species at Risk Act, using available official information available from your CWS regional office; and
- consult the Public Registry regularly for:
  - changes to the list of species in SARA Schedule 1;
  - newly identified critical habitats for species as identified in recovery strategies and action plans; and
  - new orders affecting species, residences and critical habitat.

If an EA is required for development of a TISEC project, SARA includes the following provisions that directly relate to the EA process:

All EAs conducted under federal legislation, such as CEAA, must identify any species at risk listed under SARA, or critical habitat that is likely to be affected by the project. If the project is likely to affect a listed species or its critical habitat, SARA requires that the competent minister(s) be notified. There are existing regional EA contacts within each department and notification should be sent through these contacts. CEAA regional offices can provide contact information.

SARA also requires that when an EA is being carried out on a project that may affect a listed species or its critical habitat, the potential adverse effects be identified and if the project is carried out, that measures be taken to avoid or lessen and monitor those adverse effects. Such measures must be consistent with any applicable recovery strategies, and action plans for those particular species.

SARA also amends the definition of "environmental effect" under CEAA to clarify, for greater certainty, that environmental effects include any change the project may cause to a listed wildlife species, its critical habitat, or the residences of individuals of that species.

While the prohibitions only apply to species listed as endangered, threatened or extirpated in Schedule 1[28] of SARA, the provisions related to EAs apply to all species listed in Schedule 1, including species of special concern.

In addition to identifying the adverse effects of a project on all species listed in Schedule 1, it is recommended that all other species at risk also be considered, including:

- those under consideration for addition to Schedule 1 of SARA (those species listed in Schedules 2 and 3[29]);
- those designated at risk by COSEWIC but not listed under SARA; and
- provincially or territorially-designated species.

National Energy Board

A developer of a TISEC project planning to export energy from Canada must have Export Permits from the National Energy Board (NEB). These permits outline the terms and conditions under which a company may export energy from the country.

[28] Schedule 1 is the official list of species that are classified as extirpated, endangered, threatened, and of special concern.

[29] Species listed in Schedule 2 are species that had been designated as endangered or threatened, and have yet to be re-assessed by COSEWIC using revised criteria. Species listed in Schedule 3 are species that had been designated as special concern, and have yet to be re-assessed by COSEWIC using revised criteria. Once these species have been re-assessed, they may be considered for inclusion in Schedule 1.

TABLE 3-2
CANADIAN FEDERAL PERMITS, LICENSES AND AGENCIES FOR A TISEC PROJECT

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
Fish Habitat Protection Authorization	Fisheries and Oceans Canada	Section 35 of the Fisheries Act (habitat protection provision) states that alteration of habitat requires authorization from Minister; environmental assessment required	N/A
Environmental Assessment	Canadian Environmental Assessment Agency	Administers the Canadian Environmental Assessment Act. Tidal Energy projects under 5 MW will likely need a screening level EA. Projects over 5 MW will require Comprehensive Study.	Timelines vary with the proposed project.
Navigable Waters Protection Division Authorization (Approval or Exemption)	Transport Canada	Authorization required for construction of works in/over/through inland and coastal navigable waterways.	N/A
Marine Protected Areas	Fisheries and Oceans Canada	Authorized under the Oceans Act; currently none in NB; Musquash Estuary, Bay of Fundy designated as area of interest in 2000	N/A
Marine Wildlife Areas	Environment Canada	Extend from 12 to 200 nautical miles offshore, none yet designated	N/A
National Marine Conservation Areas	Parks Canada	The only NMCAs are located in Quebec and Ontario	N/A
National Energy Board License	National Energy Board	NEB has jurisdiction only if electricity would be exported out of Canada or if federal cabinet explicitly gives NEB jurisdiction over a project	N/A
Specifies At Risk Act	Canadian Wildlife Service of Environment Canada, Fisheries and Oceans Canada, and/or Parks Canada	To prevent wildlife species from becoming extinct, to provide for the recovery of wildlife species that are becoming extinct, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened.	N/A

3.3 Massachusetts State Permitting Requirements

The primary objective of this discussion is to analyze and summarize the permitting requirements and regulatory procedures that would likely be required for a TISEC facility located in Massachusetts' waters.

Massachusetts Environmental Policy Act Review

A project is subject to Massachusetts Environmental Policy Act (MEPA) review if any review thresholds are triggered and if the project requires a Massachusetts state permit. This review is intended to give both state permitting agencies and the public an opportunity to comment on a proposal while it is still in its planning stages. Review is conducted at this stage — rather than during construction and deployment — so that environmental concerns and permitting problems can be brought to the applicant's attention and remedied before significant investment is incurred. A proposal for a project that is within MEPA jurisdiction must file an Environmental Notification Form (ENF). If significant environmental problems are identified at the ENF stage, an Environmental Impact Report (EIR) may be required.

The review thresholds identify categories of projects or aspects thereof of a nature, size or location that are likely, directly or indirectly, to cause damage to the environment. MEPA review is required when one or more review thresholds are met or exceeded. Each category contains specifications of whether MEPA review shall consist of an ENF and a mandatory EIR, or simply an ENF and other review as prescribed by the Secretary of Environmental Affairs.

Review thresholds, according to 301 CMR 11.03, exist within 12 categories:

1. Land;
2. Rare Species;
3. Wetlands, Waterways, and Tidelands;
4. Water;
5. Wastewater;
6. Transportation;
7. Energy;
8. Air;
9. Solid and Hazardous Waste;
10. Historical and Archaeological Resources;
11. Areas of Critical Environmental Concern; and
12. Regulations.

It is likely that the deployment and operation of a TISEC facility has a good chance of triggering at least one of the review thresholds.

Massachusetts Coastal Zone Management

Deployment and operation of a TISEC project in Massachusetts must be consistent with the state's coastal policies, as administered by the Massachusetts Office of Coastal Zone Management (CZM). The CZM's federal consistency review ensures that a federal activity in or affecting Massachusetts' coastal resources is consistent with the state's coastal policies, which are based on existing Massachusetts statutes and regulations and offer policy guidance on management of water quality, marine habitat, protected areas, coastal hazards, port and harbor infrastructure, public access, energy, ocean resources, and growth management.

The proponent (developer) of a project must submit: 1) the final MEPA Certificate; 2) a copy of the applicable federal license or permit application; and 3) a federal consistency certification that describes the project's compliance with CZM's policies. Following such submittals, notice is given to the public in order to solicit comments on the proposed project details. Within 180 days of public notice, CZM must issue its concurrence or objections to the federal consistency certification. If the applicant so chooses, an appeal can be filed with the U.S. Secretary of Commerce.

Massachusetts Energy Facility Siting Board

The Energy Facilities Siting Board (Board) coordinates the permitting and licensing of hydropower generating facilities by simplifying requirements for permits and licenses by acting as a facilitator between the project developer and relevant agencies.

In order to accomplish this goal, the Board has established several forms that are to be used by such agencies for permitting and licensing review of proposed hydropower generating facilities. These forms include all information required by the permitting and licensing agencies to make decisions on hydropower projects while minimizing duplication of information required for such agencies and for federal licensing.

Additionally, in a further attempt to reduce the effort associated with the filing requirements, the Board provides, whenever practicable, that such forms utilize the basic FERC application and makes provisions for developers to respond to state filing requirements by reference to their FERC application. In effect, no other forms shall be required by these agencies for permitting and licensing review of hydropower generating facilities (M.G.L. Ch. 30, Section 69H½).

The Siting Board has direct regulatory jurisdiction over: (a) generating facilities of 100+ MW; (b) transmission lines in existing electric ROW that are 10 miles or more in length and 115 kV or above; and (c) transmission lines that are not in an existing electric ROW that are one mile or more in length and 69 kV or above. It is unlikely that a pilot project would trip any of these thresholds; however, a larger project could trip the transmission line threshold if is interconnected at a voltage of 69 kV or greater. The Siting Board includes the hydropower facilitating process and is applicable to all hydropower generation projects. The Siting Board review of projects over which it has jurisdiction is adjudicatory, data intensive, and takes about a year.

Massachusetts Chapter 91 - Public Waterfront Act

Adopted in 1866, Massachusetts General Law Chapter 91 protects the public's interest in the waterways of the state. Through this program, the Massachusetts Department of Environmental Protection's (MDEP) Waterways Program regulates dredging, placement of structures, change in use of existing structures, placement of fill, and alteration of existing structures in flowed tidelands within three miles of shore, filled tidelands (both in and out of Designated Port Areas), and Great Ponds (over 10 acres in natural state), as well as certain rivers and streams.

Authorization, which is granted by the MDEP's Waterways Program, comes in the form of four different types of licenses: 1) DEP Waterways License; 2) DEP Waterways Permit; 3) License or Permit Amendment; and 4) Harbormaster Annual Permit. A TISEC project would likely be required to obtain a MDEP Waterway License, as it is likely subject to Chapter 91 and is not eligible for a Waterways Permit, License or Permit Amendment, or Harbormaster Annual Permit.

Obtaining a Chapter 91 license for a water-dependent project (i.e., a TISEC project) is a fairly complex and multi-step process, complete with a public notice and comment period, written determination issued by the MDEP, and, if necessary, an appeals process. In order for a Chapter 91 license to be granted, the MDEP must make three determinations: 1) the structures or the fill serve a proper public purpose; 2) the purpose provides greater public benefit than public detriment to the rights of the public in tidelands; and 3) the determination is consistent with the policies of the CAM Program.

Additionally, projects in state-approved municipal harbor planning districts must comply with the provisions of municipal harbor plans, which are developed under CZM regulations and implemented under Chapter 91 regulations. This requirement is handled through a Chapter 91 License.

Massachusetts Endangered Species Act

In order to coordinate both the Federal Endangered Species Act (ESA) and Massachusetts Endangered Species Act (MESA), the Massachusetts Natural Heritage and Endangered Species Program (MNHESP) publishes a map of estimated threatened and endangered species habitat within the state that potentially contains the habitat of both state-MESA and federally-ESA listed species. If a project is proposed in estimated rare or endangered species habitat, as delineated on the MNHESP database, a Rare Species Information Request Form must be submitted to MNHESP. The MNHESP will recommend measures to protect the species, if present. The permit is issued within about four weeks from receipt of a complete request.

Massachusetts Section 401 Water Quality Certification

Pursuant to a host of state and federal statutes and regulations, dredge and/or fill projects are required to obtain Section 401 WQC if: 1) the project is located in waters and wetlands subject to state and federal jurisdiction; and 2) a federal permit (e.g., FERC license) is required for the project. This permit is applicable to activities resulting in a discharge of dredged material, dredging, or dredged material disposal greater than 100 cubic yards.

This program, which is administered through the MDEP Division of Wetlands and Waterways, and its associated review process, ensures that projects resulting in the discharge of pollutants remain in compliance with a variety of state water quality programs, namely the Massachusetts Surface Water Quality Standards and the Massachusetts Wetlands Protection Act (MWPA). Upon review of the proposed project, the MDEP classifies the project either as Major (5,000 cubic yards of dredging or more) or Minor (less than 5,000 cubic yards of dredging). If the MDEP issues the 401 WQC for the proposed project, they may include mandatory conditions in the permit to ensure that state surface waters are not harmed by the project.

Massachusetts Wetlands Protection Act

Rivers in Massachusetts are subject to the jurisdiction of the MWPA. Administered by local Conservation Commissions and the MDEP's Wetlands Program, the MWPA is meant to protect Massachusetts water resources with its "no net loss of wetlands" policy and to ensure that the beneficial functions of these resources are maintained. The resources identified are protected because they fulfill the public interest to protect public and private water supply, protect fisheries, protect groundwater supply, provide flood control, protect land containing shellfish, prevent storm damage, protect wildlife habitat, and prevent pollution. Projects that affect wetlands are required to avoid impacts where possible, minimize unavoidable impacts, and mitigate for unavoidable impacts. MDEP and the individual Conservation Commissions have established performance standards that define the levels of environmental impacts that cannot be exceeded.

Proponents of a project must apply for an Order of Conditions from the appropriate municipality's Conservation Commission. This application, called the Notice of Intent (NOI), outlines the proposed project's details and its supporting plans.

Once the project is approved — with or without conditions — the Conservation Commission issues an Order of Conditions (OOC) within 21 days. Applicants can appeal the Commission's decision within 10 days, upon which the MDEP issues a Superseding Order of Conditions that either confirms or alters the original Order. Note that if a project extends beyond the boundaries of a single municipality, the developer must receive approval from multiple Conservations Commissions.

Massachusetts Coastal Wetlands

The Coastal Wetlands Restriction Act, which was enacted to protect an array of public interests associated with coastal wetland preservation, effectively prohibits development on designated wetlands. The program is currently inactive (i.e., no new areas are being added), but the restrictions are still in effect for the areas previously registered. Proposals to alter these registered wetlands are reviewed by the local Conservation Commissions, in accordance with the MWPA, whose requirements are outlined above.

Massachusetts Municipal Harbor Plans

Municipal harbor plans establish a community's objectives, standards, and policies for guiding public and private utilization of land and water within Chapter 91 Public Waterfront Act jurisdiction. Projects located within state-approved municipal harbor planning districts must comply with these plans, which may provide for an implementation program, which specifies the legal and institutional arrangements, financial strategies, and other measures to be taken to achieve the objectives of the harbor plan. Therefore, a harbor plan may prohibit certain activities applicable to a tidal energy facility, such as in-water construction and mooring placement. Projects are reviewed as a part of Chapter 91 licensing and the CZM federal consistency review.

Massachusetts Historic Properties - National Historic Preservation Act, Section 106

Administered by the Massachusetts Historic Commission (MHC), Section 106 consultation does not guarantee the preservation of a property, but rather guards against inadvertent destruction of historic resources. In order to comply with this requirement, a written opinion must be obtained from the MHC regarding the impacts of the proposed project on historic resources, which is accomplished through a Project Notification Form that is filed with the MHC. Following this submittal, an application must be submitted with MHC, complete with a project description, site description, and a copy of the relevant USGS topographic map. The MHC will then review the information and issue a determination. In this issuance, the MHC will recommend appropriate avoidance and mitigation measures if historic or archeological resources are determined to be present. This process can be used for both MEPA (15) review requirements and the Section 106 consultation with federal resource agencies (as described in Section 3.1 of this report).

Massachusetts Underwater Archeological Resources

In the case of Underwater Archeological Resources, the proponent of a project set to be constructed within state-jurisdictional waters must contact the Board of Underwater Archeological Resources to find out if the proposed activity will disturb such resources. Anyone wishing to excavate an underwater archeological site must obtain a permit from the Board. The exact location of archeological sites is not made public, in order to protect the resources from unauthorized excavation.

Massachusetts Areas of Critical Environmental Concern

Certain areas within the State of Massachusetts, both on the coast and inland, have been designated as Areas of Critical Environmental Concern (ACEC). According to state regulations, ACECs are “areas within the Commonwealth where unique clusters of natural and human resource values exist and that are worthy of a high level of concern and protection." 301 CMR 12.00. The operative effect of these regulations on permitting a TISEC project is enhanced resource protection by ensuring a closer regulatory scrutiny by certain state agencies. Specifically, the MEPA review, as well as the MDEP's Waterways (Chapter 91) and Wetland permitting become more involved. The individual effect of ACEC designation on each is as follows:

- MEPA: Review thresholds are reduced for project proposals located within an ACEC.
- MDEP Waterways (Chapter 91): Regulations prohibit new fill in ACECs and place limits on new structures. Improvement dredging and the disposal of dredged material are essentially prohibited as well.
- MDEP Wetlands: The performance standard is raised to "no adverse effects" except for maintenance dredging for navigational purposes of "Land Under the Ocean."

Massachusetts State Building Code

The minor permit requirement is intended to protect public safety by ensuring that buildings that are intended for occupancy: 1) are structurally sound; 2) constructed of appropriate materials; 3) possess adequate egress for fire safety; 4) promote energy conservation; and 5) have adequate sanitary facilities. The building code is written by the State Board of Regulations and Standards and is administered locally by Board-certified building inspectors. Required application information usually includes site description, contractor information, a description of the proposed work, and a cost estimate. Most other aspects of this permit are determined by local building inspectors. Construction of an on-shore powerhouse would likely fall under this requirement.

Massachusetts Zoning Bylaws

Even though the authority is derived from the state-enacted Massachusetts Zoning Act (M.G.L. c. 40A), the likely construction of an on-shore powerhouse would require compliance with the local municipality's zoning bylaws. Project proponents must contact local officials (usually the Planning or Zoning Board) to ensure that the proposed project is consistent with local zoning bylaws, which are in place to regulate uses of land, buildings, and other structures for the purpose of protecting the health, safety, and general welfare of present and future inhabitants.

The permits and authorizations with the respective jurisdictional agencies (as described above) are summarized in Table 3-3.

TABLE 3-3
MASSACHUSETTS PERMITS AND AGENCIES FOR A TISEC PROJECT

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
MEPA Review	MEPA Office, Executive Office of Environmental Affairs	Intends to give state permitting agencies and the public an opportunity to comment on a proposal while it is still in the planning stages to remedy environmental concerns and permitting problems. If project triggers review thresholds, an ENF and possibly an EIR must be filed.	30 days for ENF; significantly more for EIR
CZM Consistency Review	CZM	Ensures that a federal activity in or affecting Massachusetts' coastal resources is consistent with the state's coastal policies, which are based on existing Massachusetts statutes and regulations.	Maximum 180 days after MEPA certification issuance
Massachusetts Energy Facility Siting Board	same	For projects greater than 100 MW, transmission lines in ROW greater than 10 miles in length, or 69 kV and above - coordinates the permitting and licensing of hydropower generating facilities by simplifying requirements for permits and licenses by acting as a facilitator between the project developer and relevant agencies.	1 year
Chapter 91 Public Waterfront Act	MDEP	Regulates dredging, placement of structures, change in use of existing structures, placement of fill, and alteration of existing structures in flowed tidelands within three miles of shore, filled tidelands, and Great Ponds, as well as certain rivers and streams.	> 30 days (public comment period). No time given for agency review period
MESA	Division of Fisheries, Wildlife, and Environmental Law Enforcement	Protects endangered or threatened species and species of concern by prohibiting the taking, possession, transport, export, processing, sale, or purchase of such species. Permit includes recommended measures to protect endangered or threatened species and species of concern.	Approximately four weeks
Section 401 WQC	MDEP Division of Wetlands and Waterways	Ensures that projects resulting in the discharge of pollutants remain in compliance with a variety of state water quality programs, namely the Massachusetts Surface Water Quality Standards and the MWPA. Permit will include mandatory conditions in the permit to ensure that state surface waters are not harmed by the project.	>21 days (public comment period)
MWPA	Municipal Conservation Commissions, MDEP Wetlands Program	Protects water resources with "no net loss of wetlands" policy and ensures that the beneficial functions of these resources are maintained. Projects are required to avoid impacts where possible, minimize unavoidable impacts, and mitigate for unavoidable impacts.	Order of Conditions issued 21 days after approval. No time given for agency review period.
Coastal Wetlands Restriction Act	Municipal Conservation Commissions, MDEP Wetlands Program	Protects an array of public interests associated with coastal wetland preservation; effectively prohibits development on designated wetlands.	No review required.

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
Municipal Harbor Plans	CZM, MDEP	Establishes a community's objectives, standards, and policies for guiding public and private utilization of land and water within Chapter 91 Public Waterfront Act jurisdiction. Projects located within state-approved municipal harbor planning districts must comply with these plans.	See Chapter 91 and CZM.
NHPA, Section 106	Massachusetts Historic Commission (MHC)	Requires federal agencies to "take into account" the effects of project siting on properties listed or eligible for listing on the National Register of Historic Places. Project must avoid, minimize, and mitigate adverse impacts to historical resources.	See MEPA review
Underwater Archeological Resources	Board of Underwater Archeological Resources	Protects against the accidental disturbance of underwater archeological resources.	Unavailable
Areas of Critical Environmental Concern	Various	Enhanced resource protection by ensuring a closer regulatory scrutiny by certain state agencies: MEPA review and the MDEP's Waterways (Chapter 91) and Wetland permitting become much more scrutinous.	See MEPA and Chapter 91 reviews
State Building Code	Local Board-certified inspectors	Protect public safety by ensuring that buildings that are intended for occupancy are structurally sound, constructed of appropriate materials, have adequate for fire safety, promote energy conservation, and have adequate sanitary facilities.	n/a
Massachusetts Zoning Bylaws	Local Planning or Zoning Board	Ensure that the proposed project is consistent with local zoning by-laws, which are in place to regulate uses of land, buildings, and other structures for the purpose of protecting the health, safety, and general welfare of present and future inhabitants.	n/a

3.4 Maine State Permitting Requirements

In accordance with Maine statutes and regulations, a TISEC project is defined as a hydropower project which limits the number of individual state permits or licenses required to install and operate such a project. Unlike Massachusetts, Maine essentially has one agency that acts as the lead authority for the state permitting process of a hydropower project. The state-specific programs are outlined below.

Maine Waterway Development and Conservation Act

For a TISEC project in Maine, the most significant element of the permitting process is the Maine Waterway Development and Conservation Act (MWDCA) Permit. This law was created by Maine lawmakers to establish a "one-stop" permitting process that encompasses all of the different laws and review requirements of all the state agencies. The law requires that a permit be issued for the construction, reconstruction, or structural alteration (including maintenance and repair) of new or existing hydropower projects. The law requires consideration of the full range of economic, environmental, and energy benefits and adverse impacts of a hydropower project. Hydropower projects include water-powered electrical and mechanical generating projects and water storage projects (MDEP 2003). Therefore, a TISEC project would be subject to the applicable MWDCA regulations and an application for an MWDCA permit would need to be submitted to the Maine Department of Environmental Protection (MEDEP). The MWDCA is administered for MEDEP by their Dams and Hydropower Supervisor.

The Land Use Regulation Commission (LURC) reviews applications for MWDCA permits for hydropower projects located in unorganized townships and plantations. Although it is unlikely that a TISEC project would involve such lands, if a project overlaps the jurisdiction of LURC and the MEDEP, a determination will be made as to which agency has jurisdiction. For the purposes of this discussion, it is assumed that the MEDEP will have jurisdiction over TISEC projects.

It is the responsibility of the MEDEP, under this legislation, to assure that all of the separate state agency interests and permitting requirements are incorporated into the issuance of a MWDCA Permit. For example, the Maine State Planning Office administers the consistency required by the federal Coastal Zone Management Act. However, when you apply for a MWDCA Permit, it becomes the MEDEP's responsibility to provide the information necessary to the Maine State Planning Office so that they may perform their mandated Coastal Zone consistency review.

Listed below are the state programs, respective agencies, and project elements that are captured under the MWDCA permitting process.

Supporting Agency Program	Jurisdictional Authority/Agency	Project Element
Coastal Impact Review	MDEP	Waters of the U.S.
Fisheries and Wildlife Environmental Consultation	MDMR, MDIFW, MASC	Coastal wetlands and waters
Rare Plant and Natural Areas Review	MNAP Department of Conservation	The entire project - for state listed plant species
Rare Fish and Wildlife	MDMR, MDIFW, MASC	The entire project for state-listed fish and wildlife species
Maine Coastal Consistency Review (Coastal Zone Management)	Maine State Planning Office – Maine Coastal Program	Portions of project within Coastal Zone
Historic Preservation Act of 1966 Review	Maine Historic Preservation Commission	The entire project
Submerged Lands Lease or Easement	Maine Department of Conservation Bureau of Parks and Lands	Structures within or over sub-tidal lands

As presented in this list, the range of programs that require a permit or reviews is extremely varied. In addition to the agencies specified above, municipal officials, abutting landowners, and members of the general public are also given a chance to comment on the application.

A MWDCA permit will be issued when the following criteria have been met:

- The applicant has the financial and technical capabilities for the proposed project.
- The applicant has made adequate provisions for public safety.
- The project will result in significant economic benefits to the public.
- The applicant has made adequate provisions for traffic associated with project.
- The project is consistent with LURC zoning (as applicable).
- Reasonable provisions have been made to realize the environmental benefits and mitigate adverse environmental impacts.
- The advantages of the project are greater than the adverse impacts over the life of the project based upon specified environmental and energy considerations. These considerations include impacts to:
  - Soil stability, coastal or inland wetlands or the natural environment;
  - Fish and wildlife resources considering other management plans adopted by the MDIFW, the MDMR, and the Atlantic Sea Run Salmon Commission;
  - Historic and archeological resources;
  - Public rights of access to and use of the surface waters of the State for navigation, fishing, fowling, recreation, and other public uses; and
  - Energy benefits, including the increase in generating capacity and annual energy output resulting from the project and the amount of nonrenewable fuels it would replace.
- There is reasonable assurance that the project will not violate applicable state water quality standards.

There are two significant benefits of the MWDCA permitting process. The first benefit is that it becomes the MEDEP’s responsibility to make sure that the requirements of all the review agencies concerns and issues are addressed and satisfied. The second benefit is that through this process, all of the different permits and reviews will be completed and issued at one time. Both of these benefits are significant to hydropower development in Maine (i.e., consolidate all of the state-based permitting activities, and to have all of the agencies sign off under one permit provides a signal comprehensive process for applicable permitting activities in the state.

Maine Section 401 Water Quality Certification

The Federal Clean Water Act (CWA) requires that the states certify that the construction or operation of hydropower projects subject to federal licensing meets state water quality standards. The MEDEP is the WQC agency for projects in organized municipalities. By submitting an application, an applicant requests WQC pursuant to Section 401 of the CWA for the deployment and operation of hydropower generating or storage project, including a TISEC. Certification must be obtained for any activity requiring a federal license or permit which may result in a discharge into the navigable waters of the U.S.

In Maine, the WQC application is part of the MWDCA application, and the process for obtaining a WQC, the application contents, and the resulting WQC issued typically parallel the FERC License or other federal process. The WQC application must include a copy of the FERC application, and is reviewed on a parallel schedule as the FERC application. The WQC will most often include most of the same issues addressed in a FERC license (i.e., the issues addressed are not limited to simply attainment of physical water quality criteria). Associated standards to protect designated uses, such as recreation and aquatic life, are also addressed in a WQC.

Conceivably, if the hydropower project is not subject to federal licensing requirements, state WQC is not required. However, this is unlikely given the programs involved under USACE jurisdiction.

International Joint Commission Coordination

The International Joint Commission (IJC) prevents and resolves disputes between the U.S. and Canada under the 1909 Boundary Waters Treaty and pursues the common good of both countries as an independent and objective advisor to the two governments. Because the proposed Western Passage site is located next to the Maine/New Brunswick border, the developer for a TISEC project at this location should consult with the USACE in Manchester, Maine as to whether the project construction, operation, or maintenance would affect Canadian waters and consequently, whether IJC coordination is needed (pers. comm. Jay Clement, USACE, March 7, 2006).

Maine Mandatory Shoreland Zoning Act

The Shoreland Zoning Law requires that municipalities protect shoreland areas through adopting shoreland zoning maps and ordinances. The law is intended to protect water quality, limit erosion, conserve wildlife and vegetation, and preserve the natural beauty of shoreland areas. Zoning ordinances provide for what types of activities can occur in certain areas. For example, they address building size and setbacks, and the establishment of resource protection, general development, residential, and other zones. Shoreland areas include areas within 250 feet of the normal high-water line of any great pond, river or saltwater body, areas within 250 feet of the upland edge of a coastal wetland, areas within 250 feet of the upland edge of a freshwater wetland except in certain situations, and areas within 75 feet of the high-water line of a stream (MEDEP 1998).

Pursuant to the subject Act, a municipality must:

- adopt a shoreland zoning ordinance (and map) that, at a minimum, meets the state Guidelines, addresses all the statutory requirements of the Act, and has been approved by the MEDEP Commissioner;
- put administrative procedures in place to review applications and issue permits; and
- appoint a Code Enforcement Officer whose responsibility it is to enforce the ordinance provisions, collect permit fees, and record all transactions.

The installation of a transmission line and on-shore equipment associated with a TISEC project will be subject to zoning ordinances in a given municipality. Specific permit requirements will vary with project location and municipality.

The permit and authorizations with the respective jurisdictional agencies (as described above) are summarized in Table 3-4.

TABLE 3-4
MAINE PERMITS, LICENSES AND AGENCIES FOR A TISEC PROJECT.

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
MWDCA	MDEP	Establishes a "one stop" permitting process that encompasses all of the different laws and review requirements of all the state agencies. It requires that a permit be issued for construction new or existing hydropower projects and includes consideration of the full range of economic, environmental, and energy benefits and adverse impacts of a hydro project.	Within 60 days, MEDEP will; approve, disapprove or refer project to the Board. Board's decision shall be reached within 105 working days of completed application.
Water Quality Certification, pursuant to Section 401	MDEP - Bureau of Land and Water Quality	The Federal Clean Water Act requires that the States certify that hydropower projects subject to federal licensing meets State water quality standards. However, if the hydropower project is not subject to federal licensing requirements, this certification may not be required.	Notice of intent to file 30 days prior to application submittal. Application submittal prior to or concurrent with FERC filing.
Maine Mandatory Shoreland Zoning Act	Individual Municipalities	The Shoreland Zoning Law requires that municipalities protect shoreland areas through adopting shoreland zoning maps and ordinances. Specific permit requirements will vary with project location and municipality.	

3.5 New Brunswick Province Permitting Requirements

Outlined below are the New Brunswick provincial permitting issues related to a TISEC project.

Electricity License

Pursuant to Section 89 of the Electricity Act (Act), the New Brunswick Board of Public Utilities (NBPUB) is authorized to issue, amend, and renew a license authorizing a developer to provide or convey electricity to the grid. The fee which must accompany each application (i.e., form) for a license is $1,700 regardless of the number of activities for which a license has been requested. The NBPUB will establish the fee to accompany an application for renewal of a license or for amendment of a license at a later date.

The NBPUB, when issuing, amending or renewing a license, may specify the conditions under which a developer may engage in an activity subject to licensing and may specify such other conditions as the NBPUB considers appropriate. The generating and transmission activities related to a TISEC project will be subject to this electricity license.

Generation Connection Agreement

Upon consultation with a representative of the New Brunswick System Operator (NBSO), a developer of a pilot TISEC project (500 kV to 1 MW) may connect to a distribution system (typically 12.5 kV) which does not require a Generation Connection Agreement and NBSO review. Conversely, a commercial TISEC project with a 10 MW capacity will require connection to the NBSO transmission system (69 kV and above) and require a Generation Connection Agreement (pers. Communication with Scott Brown, NBSO).

The Generation Connection Agreement must be signed between the developer and New Brunswick Power Transmission (NBSO 2005). Generation equipment less than 5,000 kVA, and greater than 1,000 kVA, may be installed, where appropriate Transmission lines exist, without an extensive engineering review. The level of detail of information required depends on the site at which the connection occurs. In all cases, the customer must install the appropriate protection and obtain written approval from the transmitter, as specified in this document, before commencing interconnected operation. For facilities 1,000 kVA or smaller, transmitter approval must still be obtained, though the level of detail is less than that required for facilities greater than 1,000 kVA (NBSO 2005).

All individual generators with a minimum generating capacity of 5,000 kVA and all facilities that interconnect with the transmission system with a minimum capacity of 10,000 kVA must meet additional review and approval criteria (includes transmitter review and approval and operation and maintenance charges). They must also be equipped with supervisory control and data acquisition (SCADA) equipment. For staffed facilities, a telephone line dedicated to voice communications with the system operator must be provided. For unstaffed facilities, the customer must provide an alternative means of communications to meet the requirements of the systems operator (NBSO 2005).

New generators also have to undergo a System Impact Study, either as a Network Resource or a Point-to-Point Resource. An example of a Network Resource is a project selling to NB Power whose power does not require a specific transmission path. An example of a Point-to-Point Resource is a project selling to New England whose power does require a specific transmission path (pers. comm. New Brunswick TISEC Advisory Group March 16, 2006).

After receiving a request for service, the transmission provider will determine whether a System Impact Study (for both network resource and point-to-point) is needed. The transmission provider will within thirty days of receipt of a completed application (actual application process will vary depending on the project), tender a System Impact Study Agreement pursuant to which the eligible customer will agree to reimburse the transmission provider for performing the required System Impact Study. For a service request to remain a completed application, the eligible customer shall execute the System Impact Study Agreement and return it to the transmission provider within fifteen days. If the eligible customer elects not to execute the System Impact Study Agreement, its application shall be deemed withdrawn and its deposit shall be returned with interest (NBSO 2005).

Crown Land Utility Lease

Crown Land includes all or any part of land (including land covered by water) that is not privately owned in the Province of New Brunswick. These lands are managed by various provincial Departments, but the application process is administered by the New Brunswick Department of Natural Resources (NBDNR). Extended use of Crown Land or activities that involve development on Crown Land requires a formal agreement. This authorization may be given after a review of the application, by issuing a formal document known as a Lease, Easement, or License. The Utility Leases are issued for a term of 10 years.

Upon submittal of a completed application and meeting the eligibility requirements, the NBDNR will send a letter of acknowledgement advising the developer of the application review process. The application will be reviewed by NBDNR as well as other governmental agencies. The time for the review process will vary depending on the type of request. The review process is expected to take between six and 21 weeks and the developer will be notified if the application is accepted.

A Utility Lease will be required for a TISEC project if any part of the facility is not on privately owned land. The developer may be required to provide a copy of the Environmental Impact Assessment (EIA) determination letter from the Department of the Environment and Local Government (DELG) before the lease is issued. In addition, there may be activities related to the EIA that need to be conducted prior to issuance of a Utility Lease.

The Crown Lands Branch at the Department of Natural Resources is currently investigating the development of a lease policy specifically designed for tidal energy developers (pers. comm. New Brunswick TISEC Advisory Group March 16, 2006).

Watercourse and Wetland Alteration Standard Permit

The purpose of the Watercourse and Wetland Alteration Regulation is to protect the streams, rivers, wetlands, and lakes of New Brunswick from work or ground disturbance in or near watercourses or wetlands. While the generation portion of a TISEC project will be in the tidal region, the transmission line may be installed in areas requiring a permit. The regulation prohibits any watercourse or wetland alteration, or causing any watercourse or wetland alteration to be commenced, made or performed, unless authorized to do so by a permit issued by the Minister of the Environment and Local Government.

The process involves submittal of an application form, including the required drawings to scale and the application fee. Provincial review can take up to two months. However, if limited impacts to wetlands are anticipated, certain activities qualify for Provisional Permits which can be obtained from the local office of the DELG. For example, the activities related to the installation of a transmission line from the shore station to the grid (cutting of non-marketable woody vegetation, cable crossings, etc.) are listed as activities qualifying for a Provisional Permit.

Certification of Approval to Construct (Air and Water Quality Protection)

New Brunswick's Environmental Impact Assessment Regulation 87-83 is designed to identify the environmental impacts prior to the construction phase of any project, so that potential impacts can be avoided or reduced to acceptable levels before they occur. The EIA process gives technical specialists from government agencies, as well as local residents and the general public, a chance to provide their input to the decision-making process regarding specific development proposals. The EIA review process must be completed before any project subject to EIA can proceed. Although the EIA Regulation grants the Lieutenant-Governor in Council the authority to prevent projects from proceeding, it is not intended to be a mechanism for stopping developments for which the anticipated impacts can be avoided or reduced to acceptable levels through mitigation.

Under the Regulation, any person that proposes certain types of projects, listed in Schedule "A" of the Regulation, is required to register information about the proposal with the DELG.

Schedule "A" lists several activities related to the installation and operation of a TISEC project. Specific activities include:

- all electric power generating facilities with a production rating of three MW or more;
- all enterprises, activities, projects, structures, works or programs affecting any unique, rare or endangered feature of the environment; and
- all enterprises, activities, projects, structures, works or programs affecting two hectares or more of bog, marsh, swamp or other wetland.

The registration needs to include complete and accurate descriptions of the project location, proposed activities, the existing environment, potential impacts, and proposed mitigation efforts. The review and approval process can become quite involved depending on whether or not a Comprehensive Review is required.

- **Review Process**

The Project Assessment Branch of the DELG performs a Determination Review for all registered projects. The primary purpose of the review is to identify and evaluate the environmental issues surrounding the proposed project and determine whether or not a Comprehensive Review is warranted. The proponent (developer) of the project must demonstrate that the affected public and other stakeholders have been given the opportunity to become involved in reviewing the project. The Minister evaluates the information from the DELG, proponent's responses and stakeholders concerns, and decides whether a Comprehensive Review is required. If it is decided that the EIA process carried out during the Determination Review is sufficient, the Minister will issue a Certificate of Determination and will notify the proponent that the undertaking may be carried out subject to any appropriate terms or conditions established by the Minister.

■ Comprehensive Review

The Comprehensive Review involves several steps with the goal being to engage agencies and stakeholders in a process designed to identify methods of enhancing positive impacts and minimizing negative impacts resulting from the proposed project. The completion of an EIA study and preparation of a report describing the results, are the critical components of the EIA process. The developer is responsible for the cost of the study that, in most cases, is carried out by a team of consultants offering a variety of technical expertise.

Department of Agriculture, Fisheries and Aquaculture Review

The New Brunswick Department of Agriculture, Fisheries and Aquaculture reviews aquaculture site applications. This agency or a similar group may likely review tidal site applications as part of the EIA process (Pers. comm. New Brunswick TISEC Advisory Group March 16, 2006).

The permit and authorizations with the respective jurisdictional agencies (as described above) are summarized in Table 3-5.

TABLE 3-5
NEW BRUNSWICK PERMITS, LICENSES AND AGENCIES FOR A TISEC PROJECT

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
Electricity License	NB Board of Commissioners of Public Utilities	Under Section 89 of the Electricity Act, the Board of Commissioners of Public Utilities issues licenses authorizing electric generation	n/a
Generation Connection Agreement	NB Power Transmission	Required if connecting to the transmission system. Engineering review required - smaller facilities require less detail. New generators must undergo a System Impact Study.	n/a
Crown Land Utility Lease	NBDNR	Crown Lands include all land (and submerged land) not privately owned; Crown Lands are administered and controlled by the DNR under the Crown Lands and Forests Act.	Six to 21 weeks for NBDNR review.
Watercourse and Wetland Alteration Standard Permit	NB DELG	Reg. 90-80 under NB Clean Water Act C-6.1; required for construction activities in watercourse involving deposit or removal of any fill; “more ambitious projects can take as long as two months”	Up to two months for agency review.

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
Certification of Approval to Construct (Air and Water Quality Protection)	NB DELG	Governed by [provincial] Clean Water Act, Clean Air Act, and Clean Environment Act; involves environmental impact assessment (but electric power generating facilities that do not impact rare/endangered resources and have production rating <3 MW are exempt from provincial environmental impact assessment).	n/a
Department of Agriculture, Fisheries and Aquaculture Review	NB DAFA	Reviews aquaculture site applications. This agency or a similar group may likely review tidal site applications as part of the EIA process	n/a

3.6 Nova Scotia Province Permitting Requirements

Nova Scotia has a history of tidal power development. One of only three tidal power plants in the world was constructed at Annapolis Royal, Nova Scotia in 1984. However, this facility is quite different from the TISEC projects addressed by this report, the Annapolis Royal Project includes a concrete structure to form a barrage of the seawater to generate electricity as a result of differential, as opposed to free-flowing tidal water of a TISEC project. This 20 MW project, funded by the provincial and federal governments, started off as a pilot project, but now produces more than 30 million kWh per year. As recently as October of 2005, the Nova Scotia Department of Energy unveiled a green energy framework calling for the development of "energy efficiency, renewable and alternative energy, and cleaner energy technologies."[30] This call for the development of cleaner energy places tidal power on the list of important research and development initiatives (Nova Scotia Department of Energy 2005). As such, Nova Scotia is primed for further developments in tidal energy. This section summarizes the permitting requirements and regulatory procedures that would likely be required of a TISEC facility located in Nova Scotia waters.

Nova Scotia Utility Board Approval

Under the Public Utilities Act, Revised Statutes of Nova Scotia, 1989, Chapter 380, the Nova Scotia Utility Board has general supervisory authority over electrical utilities and producers. In order to operate within the province, a developer must be granted approval by the Board. This approval, although not a licensing process per se, is applied or petitioned for "in letter format describing what is being sought, the particulars of the utility to be operated and by whom". The specific

[30] *See* http://gov.ns.ca/energy/AbsPage.aspx?id=1503&siteid=1&lang=1, Retrieved January 12, 2006.

requirements will vary with each project. The waiting period and other related requirements associated with this approval vary depending on the size and complexity of the project, and a public hearing may be required. However, once a project is granted by the Board, the approval never expires (Nova Scotia Utility and Review Board *Undated*).

Crown Lands Deed or Grant: Water Lot Grant

The Nova Scotia Department of Natural Resources (NSDNR), under the Crown Lands Act, Revised Statutes of Nova Scotia, 1989, Chapter 114, Section 16(1)(a), must grant approval to anyone needing ownership, lease, deed, or other conveyance of submerged land in coastal waters to permit the construction of large wharves, causeways, infills, or breakwaters. To file for this approval, an applicant can make a request in writing to the Land Administration Division of the NSDNR. As a part of the approval, the applicant may need to have the land surveyed at their own cost, as well as pay appraisal costs, an administration fee, and the market value of the land. The approval may be granted as long as two years after the initial application is submitted; but, as with the Utility Board Approval, this approval will not expire (NSDNR 2004*a*).

Water Allocation: Water Approval and Watercourse Alteration

Activities Designation Regulations cite certain activities integral to the operation of a hydropower facility (i.e., “the construction and maintenance of a ... fishway or other instream structure”) as requiring a water approval license from Nova Scotia Environment and Labour. However, for others (i.e., “the use of seawater [or] the use of brackish water from an intertidal zone of a river estuary”), this license is not required. Therefore, while this would be a requirement of a typical hydroelectric facility, it is unlikely that this license would be required for a TISEC project (Nova Scotia Environment and Labour *Undated*).

Mooring Permit - Submerged Crown Land

In order to place a permanent or semi-permanent mooring associated with a TISEC facility on Submerged Crown Land in Nova Scotia, a mooring permit is required from Land Administration Division of the NSDNR. The submitted application must include a plan showing location and property boundaries. Additionally, if the mooring is within 60 meters of the ordinary high-water mark, written consent of the immediately adjacent upland owner must be provided with the application upon submission. This permit can be renewed through automatic annual renewals, or it can be valid for a specified amount of time under three years. Furthermore, because of overlapping jurisdiction, an approval or exemption under the Navigable Waters Protection Act is required from the Department of Fisheries and Oceans, Canada (NSDNR 2004*b*).

Environmental Assessment Approval

Environmental Assessment of a TISEC facility site is an information gathering process used to identify and assess the potential environmental effects of construction and operation of the facility prior to its development. It is also a process that provides the public with an opportunity to contribute to decision making. To kick off this procedure, a registration form is submitted to Environmental Assessment Branch of Nova Scotia Environment and Labour.

In order to gather the necessary amount of registration information and to engage the proper stakeholders, the environmental assessment information is referred to Nova Scotia and Federal governmental departments, the local municipal office, Aboriginal groups, NGOs, and the general public.

There may be additional information required as part of the Environmental Assessment. The level of information required is based on the particular activity. Larger projects (Class I), including hydroelectric generating projects in excess of 10 MW, may require a focus report or an environmental assessment report. However, these reports may not be required for a TISEC project with a generating capacity less than 10 MW. Within 25 to 364 days, depending on the type of undertaking and the level of environmental assessment required, the government issues their response. These time periods do not include the time it takes for proponents to prepare the necessary reports (Nova Scotia Environment and Labour 2004).

The permit and authorizations with the respective jurisdictional agencies (as described above) are summarized in Table 3-6.

TABLE 3-6
NOVA SCOTIA PERMITS, LICENSES AND AGENCIES FOR A TISEC PROJECT

PERMIT/ AUTHORIZATION	AGENCY	INTENT OR REQUIREMENT	TIME (est.)
Utility and Review Board Approval	Nova Scotia Utility and Review Board	Board has general supervisory power over electrical utilities under Public Utilities Act, Revised Statutes of Nova Scotia, 1989, Ch.380; "not a licensing process" but must have approval to sell electricity; application or petition made "in letter format describing what is being sought, the particulars of the utility to be operated and by whom"; approval does not expire; requirement/timeframe varies with project.	n/a
Crown Lands Deed or Grant: Water Lot Grant	NSDNR	DNR requests subject to Integrated Resources Management Review; grant is for "anyone who needs ownership of submerged land in coastal waters to permit the construction of large wharves, causeways, infills or breakwaters"; waiting period up to 2 years; does not expire; authorized by Crown Lands Act, Revised Statutes of Nova Scotia, 1989, Ch.114, Sec.16(1)(a); NOTE different process for wind energy in NS: letter of authority (2 yrs) or lease (20 yrs) issued.	Up to two years
Water Approval	Nova Scotia Department of Environment and Labour	Described in Activities Designation Regulations (N.S. Reg. 47/95); authorized by Section 66 of Environment Act; approval required to modify watercourse (fresh or seawater); get application form from Regional or District Office; 60 day waiting period if all necessary information is in; review process with federal/provincial/local agencies; water license for power generation confers fee of $1.70 per horsepower of rated capacity.	60-day waiting period
Mooring Permit	NSDNR	For "anyone who wants to place a permanent or semi-permanent mooring on submerged crown land"; does not cover bodies of freshwater; permit valid for three years or one year with automatic renewal; obtain application form from Local or Area Office.	n/a
Environmental Assessment Approval	Nova Scotia Department of Environment and Labour	For all projects listed in Schedule A of Enviro.Assess. regulations: includes specifically only wind-derived electric generating facilities > or = 2 MW and electric generating facilities (including hydro) > or = 10 MW, other projects at Minister's discretion; authorized by the Environmental Act. No application form- a registration document must be submitted to Environmental Assessment Branch (contact for additional info. Branch refers EA to other provincial/federal agencies.	25 to 365 days for approval

Section 4
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