mitigative measures related to minimizing the effect of the Project on wetland vegetation is provided in Section 5.4 (Wetland VEC).

Data on the known distribution of rare plants within the transmission line corridor will be communicated to NSPI for their use during construction and maintenance activities. It is recommended that a qualified botanist or similarly qualified professional will be engaged to identify the locations of known rare plant occurrences along the transmission route to assist in their avoidance. Furthermore, it is recommended that NSPI perform rare plant surveys along the portion the portion of the abandoned transmission RoW which has not been surveyed.

5.6 FRESHWATER FISH AND FISH HABITAT

Freshwater Fish and Fish Habitat is included as a VEC because of the potential interactions that both may have with the Project and because both fall under regulatory protection. For these reasons, Freshwater Fish and Fish Habitat were also included in the EIS guidelines. The primary freshwater system with the potential for Project-VEC interactions on the Donkin Peninsula is Schooner Pond (surrounded by Baileys Wetland) and its tributaries. This freshwater system has the potential to be affected by long-term disposal of coal waste as well as the water treatment associated with mining activities. Several additional freshwater systems exist along the transmission line route between the Project site and Victoria Junction.

While surface water quality is being assessed as part of an independent VEC (see Section 5.2), it is also a component of fish habitat. As such, a high-level discussion of water quality as it relates to fish and fish habitat will be included in this section. Freshwater fish and fish habitat are also affected by changes in associated wetlands and hydrology; however, potential interactions between Project activities and these components of the aquatic environment are addressed in Section 5.4 (Wetlands) and Section 5.2 (Water Resources).

In the context of the Freshwater Fish and Fish Habitat VEC, the following definitions apply:

“Fish” is defined in Section 2 of the *Fisheries Act* and includes: (a) parts of fish, (b) shellfish, crustaceans, and any parts of shellfish, or crustaceans, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, and crustaceans.

“Fish habitat” as defined in Section 34(1) of the *Fisheries Act* includes spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. Fish habitat will be assumed to include the physical (*e.g.*, substrate/sediment, temperature, flow velocity and volumes, riparian vegetation), chemical (*e.g.*, water quality), and biological (*e.g.*, fish, benthic macroinvertebrates, periphyton, aquatic macrophytes) attributes of the aquatic environment that are required by fish to carry out life cycle processes. In this context, surface water quality is described as the chemical, physical (*e.g.*, temperature, clarity), and biological (*e.g.*, bacteria, algae) attributes of surface water as they relate to the protection of aquatic life.

"Watercourse": The Nova Scotia *Environment Act* defines a watercourse as any creek, brook, stream, river, lake, pond, spring, lagoon or any other natural body of water, and includes all the water in it, and also the bed and the shore (whether there is actually any water in it or not). It also includes all ground water (NSE 2012a).

5.6.1 Scope of Assessment

5.6.1.1 Regulatory Setting

Fish and fish habitat are protected through federal and provincial legislation. Fish habitat is protected under the *Fisheries Act* and by DFO's *Policy for the Management of Fish Habitat* (DFO 1986). The *Policy for the Management of Fish Habitat* is regulated by Sections 20, 21, 22, 30, 32, 35, 37, 40 and 43 of the *Fisheries Act* which is administered by DFO.

The policy applies to those habitats directly or indirectly supporting those fish stocks or populations that sustain commercial, recreational or native fishing activities of benefit to Canadians. DFO's long term policy objective is the achievement of an overall net gain of the productive capacity of fish habitats. The no net loss principle will strive to balance unavoidable habitat losses with habitat replacement on a project by project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented.

Should there be a requirement for the harmful, alteration, disruption or destruction (HADD) of fish habitat or the destruction of fish by any means other than fishing in the freshwater aquatic environment, an authorization under the federal *Fisheries Act* (ss.35(2) and s. 32) will be required. In the case where a *Fisheries Act* Authorization will be issued there will also be a requirement for the proponent to implement a fish habitat compensation plan to facilitate a no net loss of productive capacity.

Provincial regulations applicable to fish habitat protection include the Nova Scotia *Environment Act* and the Activities Designation Regulations which require completion of an application for a Division I Water Approval for Watercourse Alterations. The approval is issued by NSE.

Endangered aquatic species that are protected federally under SARA are listed in Schedule 1 of the Act. As discussed in more detail in Section 5.6.2.1.1, none of the freshwater aquatic species known to inhabit the LAAs are listed under Schedule 1 of SARA. Certain aquatic species are also protected under the NS ESA. The conservation and recovery of species assessed and legally listed under the NS ESA is coordinated by the Wildlife Division of the NSDNR. Section 5.6.2.1.1 discusses the freshwater species of conservation concern inhabiting the LAA that are protected under the NS ESA.

Surface water quality is regulated through federal and provincial legislation. Water quality of watercourses is protected under Section 36 of the *Fisheries Act* and the Nova Scotia *Environment Act*. However, for Sections 36 to 42, Environment Canada administers those aspects dealing with the control of pollutants affecting fish. The Canadian Council of Ministers of the Environment (CCME) established Guidelines for the Protection of Freshwater Aquatic Life (FWAL), for many water quality parameters (CCME 2007). While these are guidelines and not standards, it is generally accepted as best practice in EA to undertake technical and economically feasible approaches to mitigate project activities to meet the objectives of the CCME Guidelines and all relevant updates.

As well, water crossings that may require Authorization under the *Navigable Waters Protection Act (*NWPA) associated with the Navigable Waters Protection Program (NWPP). The NWPP ensures the public's right to navigate Canada's waters without obstruction. This is accomplished through the administration of the NWPA. The NWPA is a federal law designed to protect the public right of navigation. In order to minimize the impact to navigation, the NWPP ensures that works constructed in navigable waterways are reviewed and regulated.

Amendments to the NWPA came into force on March 12, 2009 as part of the federal government's initiative to accelerate major resource and infrastructure projects. These amendments streamline the federal review process by establishing classes of waters and works (projects) that do not require an Application or Approval through the NWPP because they are "minor" in nature.

The following specific classes of minor navigable waters are incorporated into the amendments to the NWPA (Section 13) by means of the Minor Works and Waters (Navigable Waters Protection Act) Order:

- Private lakes
- Artificial irrigation channels and drainage ditches
- Minor navigable waters

Navigable water assessments (according to the Order guidelines) were performed concurrently with the aquatic field survey conducted by Stantec biologists from August 30, 2010 to September 3, 2010 along the proposed rail corridor. The goal was to determine if the watercourses within the transport corridor could be classified under one of the specific classes of minor navigable waters, in particular Class 3 (minor navigable waters).

Transport Canada (TC) has established five navigable water characteristics to be used in determining whether or not particular navigable waters meet the definition of minor navigable water. If a section of navigable water is classified as minor, an application for approval under the NWPA is not required for any work on that section.

5.6.1.2 Influence of Consultation and Engagement on the Assessment

During the stakeholder and public engagement process, the main issues raised by stakeholders and community members was the potential impact on waterbodies and streams on the peninsula and along on the transmission line for recreational fishing.

5.6.1.3 Selection of Environmental Effects and Measurable Parameters

The environmental assessment of Freshwater Fish and Fish Habitat is focused on the following environmental effects:

- Change in Fish Habitat
- Change in Mortality Risk

The Project has the potential to affect Freshwater Fish and Fish Habitat through changes in fish habitat as well as fish survival. The *Fisheries Act* prohibits the unauthorized harmful alteration, disruption, or destruction of fish habitat as well as the unauthorized killing of fish; therefore, these effects are considered most relevant for assessment.

The measureable parameters that will be used to assess potential Project effects to Freshwater Fish and Fish Habitat and their rationale for selection are described in Table 5.6.1.

Table 5.6.1 Measurable Parameters for Freshwater Fish and Fish Habitat

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Fish Habitat	• Area of habitat altered (m^2) • Change in water quality • Change in water flow rates or flow obstructions (*e.g.*, fish passage obstructions) • Change in drainage area • Reduction of riparian vegetation • Change in substrate composition	The *Fisheries Act* provides for the protection of fish habitat. The unauthorized harmful alteration, disruption or destruction of habitat and deposit of a deleterious substance into waters frequented by fish is prohibited under the *Fisheries Act*. Quantification of these actions is necessary to request authorization and calculate compensation requirements. Water quality suitable for fish populations to live can be measured by several *in situ* and/or laboratory tested parameters. Total Suspended Solids (TSS) is an indicator of the amount of suspended sediment in a watercourse and is a good measure of the quality or viability of fish habitat. Changes in temperature (which may result from a reduction of riparian vegetation) and dissolved oxygen can affect the quality of habitat and in extremes, result in fish mortality. Fish habitat is also limited by pH levels, with ranges outside optimal levels resulting in stress on fish and other biota on which fish depend. Water and sediment quality sampling results can be measured against CCME aquatic guidelines and Interim Sediment Quality Guidelines and Probable Effects Level to assess environmental effects. Changes in water flow through change in drainage area and/or flow obstructions can affect the quality or viability of fish habitat, including in the form of changes to fish passage.

Table 5.6.1 Measurable Parameters for Freshwater Fish and Fish Habitat

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Mortality Risk	• Change in direct mortality risk (*e.g.*, from sedimentation, toxicity exposure) • Change in acute and chronic toxicity	Section 32 of the *Fisheries Act* prohibits the unauthorized killing of fish by means other than fishing. Fish mortality is the ultimate measure for change in fish populations. Baseline data on fish populations and observed fish accidentally killed as a result of the Project would inform effects on mortality.

5.6.1.4 Temporal and Spatial Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on Freshwater Fish and Fish Habitat include the periods of construction, operation and maintenance, and decommissioning and reclamation.

The spatial boundaries for the environmental effects assessment of the Freshwater Fish and Fish Habitat VEC are defined below.

Project Development Area (PDA): The PDA includes the area of physical disturbance (*i.e.*, "footprint" for the Project including infrastructure for the mine site as well as stockpiles, coal waste piles, conveyor system, 138 kV transmission line, and trucking routes. The PDA also includes the barge load-out facility and transshipment mooring and vessel route between the two.

Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the PDA and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. For Freshwater Fish and Fish Habitat, the LAA is defined differently on the Donkin Peninsula and along the transmission line route.

On the Donkin Peninsula, the LAA is defined by the drainage areas. Schooner Pond and the tributaries that feed into it comprise one LAA. All other known freshwater surface waters on the Donkin Peninsula are understood to drain directly into the Atlantic Ocean; therefore, the remainder of the peninsula comprises a second LAA.

The transmission line route travelling from the Donkin Peninsula to Victoria Junction includes several watercourse crossings representing multiple drainage areas. To focus the assessment of freshwater fish and fish habitat along the transmission line route, the transmission line corridor itself will represent a single linear LAA. This transmission line LAA will encompass the freshwater resources physically crossed by the corridor.

To summarize, the Freshwater Fish and Fish Habitat VEC assesses three LAAs (see also Figure 5.6.1):

- Schooner Pond and the tributaries feeding it within the Donkin Peninsula boundaries – referred to herein as the Schooner Pond LAA
- The remainder of the Donkin Peninsula – referred to herein as the Donkin Peninsula LAA
- The transmission line corridor (*i.e.*, all watercourse crossings falling within it) – referred to herein as the transmission line corridor LAA

Regional Assessment Area (RAA): The RAA is limited to and includes the primary watershed encompassing the Donkin Peninsula and the transmission line corridor (Nova Scotia Geomatics Centre primary watershed 1FJ) transmission line. The RAA is the area within which cumulative environmental effects for freshwater fish and fish habitat may occur, depending on physical and biological conditions and the type and location of other past, present, and reasonably foreseeable projects.

5.6.1.5 Residual Environmental Effects Description Criteria

Terms that are used to characterize residual environmental effects for Freshwater Fish and Fish Habitat are presented in Table 5.6.2.

Table 5.6.2 Characterization Criteria for Residual Environmental Effects on Freshwater Fish and Fish Habitat

Criterion	Description
Direction	**Positive:** condition is improving compared to baseline habitat quality or population status **Neutral:** no change compared to baseline habitat quality or population status **Adverse:** negative change compared to baseline habitat quality or population status
Magnitude	**Negligible:** no measurable adverse effects anticipated **Low:** measurable effects to habitat function anticipated in low-sensitivity habitats and no measurable reduction in number of any fish species anticipated **Moderate:** measurable effects to habitat function anticipated in moderately sensitive habitats or anticipated mortality risk to non-listed species **High:** measurable effects to habitat function anticipated in highly sensitive habitat or habitat designated as important for listed species or anticipated mortality risk to listed species
Geographical Extent	**Site-specific:** effects restricted to habitat within the PDA **Local:** effects extend beyond PDA but remain within the LAA **Regional:** effects extend into the RAA
Frequency	**Once:** effect occurs once **Sporadic:** effect occurs more than once at irregular intervals **Regular:** effect occurs on a regular basis and at regular intervals **Continuous:** effect occurs continuously

Table 5.6.2 Characterization Criteria for Residual Environmental Effects on Freshwater Fish and Fish Habitat

Criterion	Description
Duration	**Short-term:** effects are measurable for days to a few months **Medium-term:** effects are measurable for many months to two years **Long-term:** effects are measurable for multiple years but are not permanent **Permanent:** effects are permanent
Reversibility	**Reversible:** effects will cease during or after the Project is complete **Irreversible:** effects will persist after the life of the Project, even after habitat restoration and compensation works
Ecological Context	**Disturbed:** effect takes place in an area that has been previously adversely affected by human development or in an area where human development is still present **Undisturbed:** effect takes place in an area that has not been adversely affected by human development

5.6.1.6 Threshold for Determining the Significance of Residual Environmental Effects

Potential exists for significant residual adverse environmental effects on freshwater fish and fish habitat to occur as a result of Project activities. The significant effects criteria for each component of the VEC are defined below.

A **significant residual adverse environmental effect** on fish and fish habitat is one that alters fish habitat physically, chemically, or biologically, in quality or extent, in such a way as to cause an adverse change in the ecological function of that habitat, such that natural recruitment would not re-establish the community to its original composition, density and extent in one generation. It is also considered a significant adverse environmental effect if the alteration of the habitat results in an unmitigated or non-compensated net loss of fish habitat as defined in the *Fisheries Act*. Additionally, if fish habitat is altered in such a way as to affect an adverse change (caused by avoidance and/or mortality) in the distribution or abundance of a fish species or community that is dependent upon that habitat, it is considered a significant adverse environmental effect on fish and fish habitat.

There are both federal (SARA) and provincial (Nova Scotia *Endangered Species Act*) acts for the protection of species at risk, and there are different levels of protection afforded a species within these Acts depending on the species rarity ranking. For example, only those species currently listed in Schedule 1 of SARA are protected under the Act. Given that the LAAs for the Freshwater Fish and Fish Habitat VEC do not support any fish species listed under SARA, the significance criteria are more applicable to species covered by the Nova Scotia *Endangered Species Act*.

A **significant residual adverse environmental effect** on surface water quality is one that causes a long-term Project-related exceedance of the CCME guidelines for the protection of aquatic life (CCME 2007).

5.6.2 Existing Conditions

Assessments of Freshwater Fish and Fish Habitat were completed on the Donkin Peninsula for the Donkin Underground Exploration Project Environmental Assessment (CBCL 2008). This work was carried out by CBCL in July 2008 in the area of Baileys Wetland and the transmission corridor. Additional surveys were conducted by Stantec along the transmission corridor from August 30, 2010 to October 8, 2010.There were three separate site visits conducted to gather information on the existing water crossings. All field-based site visits and watercourse assessments were completed prior to the decision to locate the coal and waste rock disposal sites on the Donkin Peninsula. As such, freshwater resources were not assessed on the peninsula in relation to potential interactions with either of the proposed disposal pile locations. Follow-up field visits will be completed to focus on the watercourses with the potential to be directly affected by the proposed land-based disposal of coal and waste rock on the Donkin Peninsula.

Based on a review of desktop information and previous studies, 19 watercourses were identified within the proposed transmission corridor. The detailed habitat assessments employed an internal Stantec sampling protocol. The sampling protocol used is based on multiple existing protocols including the Environment Canada CABIN protocol (Canadian Aquatic Biomonitoring Network; Reynoldson *et al*. 2007), the Ontario Benthos Biomonitoring Network (OBBN) protocol (Jones *et al.* 2005), and the modified New Brunswick Department of Natural Resources (NBDNR) and Fisheries and Oceans Stream Assessment Protocol (Hooper *et al*. 1995). The stream assessment included the identification of physical units (*i.e.*, run, riffle, or pool), designation of substrate type, and description of the riparian zone. The presence or absence of macrophytes, algae, over-head cover, and woody debris was also recorded since all of these habitat features affect the ability of the watercourse to support fish communities. The depth and width (wetted and bankfull) of streams and rivers were recorded as well.

One *in situ* water quality sample was taken within each identified watercourse. The water quality measurement was taken within 10 m of the downstream end of the crossing location. The flow state at the time of the water quality sampling was also recorded. Measurements were collected using a handheld water quality meter (Yellow Springs International (YSI) 556 MPS unit) and included dissolved oxygen, pH, water temperature and specific conductivity.

A presence-absence electrofishing survey was carried out at selected streams to supplement a full baseline fish habitat survey (including electrofishing) undertaken by CBCL in 2008.The intent of the 2010 electrofishing survey was to “spot check” the earlier fishing survey. Electrofishing was completed using a Smith-Root Model LR-24 backpack electrofishing unit, operated by two qualified aquatic specialists. The electrofishing survey was completed starting at the downstream end of watercourses within three watercourses anticipated to connect to known or suspected fish-bearing watercourses.

In the one lentic watercourse (Glace Bay Lake), electrofishing was determined to be ineffective based on the elevated water conductivity. Instead, baited minnow traps were set overnight to target littoral zone species, the littoral zone of the lake was chosen as that is the area has the highest potential for effects from Project activities.

5.6.2.1 Overall Description of Freshwater Resources within the RAA

Freshwater habitats on the Donkin Peninsula are a mix of two lentic and six lotic systems. Both lentic and lotic watercourses from the core of the peninsula drain into Baileys Wetland then to Schooner Pond Cove and the Atlantic Ocean. The lotic watercourse on the eastern fringe of the peninsula drains directly into the Atlantic Ocean.

Within the PDA, surface water from site drainage and the water treatment facility accumulate in the DEVCO settling pond before discharging into Schooner Pond Cove. Water levels in Baileys Wetland were previously controlled by a weir type structure at the connection to Schooner Pond Cove (CBCL 2008). However, the structure is currently blocked due to storm effects on the old access road effectively creating a berm between Baileys Wetland and Schooner Pond Cove. Baileys Wetland now drains by overland flow to Schooner Pond Cove. This berm impounds Baileys Wetland and reduces salt water intrusion into the wetland and its tributaries. Fish habitat is present within Schooner Pond as evidenced by the observation of ninespine stickleback (*pungitius pungitius*) and banded killifish (*Fundulus diaphanous)*. No salmonids were caught during the 2008 surveys, though previous stocking of Baileys Wetland and the DEVCO settling pond was reported (CBCL 2008).

Within the transmission line corridor, one watercourse was observed to be estuarine. Estuarine environments fill and empty with seawater based on changes in sea level but may maintain a freshwater baseline depth even at low tide such as was observed at the crossing of Big Glace Bay Lake. Estuarine environments are generally considered rich environments in which nutrients can be supplied from freshwater and marine sources as well as recycled from the sea bed; this in turn can lend to the support of a range of estuarine-tolerant organisms, including benthic invertebrates, fishes, plants and birds.

The remainder of the watercourses within the transmission corridor are freshwater lotic systems. The results of the field study confirmed the presence of several small bodied and multiple salmonid fish species within the Project area. Diverse fish habitat was observed across the transmission line corridor LAA, resulting in multi-species fish assemblages within many of the streams, rivers and estuaries assessed.

Further detail on the freshwater fish and fish habitat conditions within the Donkin Peninsula and the transmission corridor are included in Sections 5.6.2.2 and 5.6.2.3, respectively.

5.6.2.1.1 Species of Conservation Interest

Species At Risk

Endangered aquatic species are protected federally under Schedule 1 of SARA. As defined in SARA, "aquatic species" means a wildlife species that is a fish as defined in Section 2 of the *Fisheries Act* or a marine plant, as defined in Section 47 of the Act. The purpose of this Act is to protect wildlife Species at Risk and their critical habitat. SARA is administered by Environment Canada, Parks Canada Agency, and DFO. Those species listed as “Endangered” or “Threatened” in Schedule 2 or 3 of SARA may also be considered as Species at Risk, pending regulatory consultation.

There are two freshwater fish species and one mussel species in Nova Scotia with special conservation status as designated by SARA:

- Atlantic whitefish (*Coregonus huntsmani*) – listed as “Endangered”
- Atlantic salmon [Inner Bay of Fundy (iBoF) population] (*Salmo salar*) – “Endangered”
- Yellow lampmussel (*Lampsilis cariosa*) – listed as a species of “Special Concern”

Of these species, only the yellow lampmussel is known to occur in Cape Breton, NS. The distribution of the yellow lampmussel is currently limited to the Sydney River (DFO 2010a). Therefore, Project activities are not anticipated to interact with the species.

There are three additional Nova Scotia fish species (or populations) listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that are not currently afforded the additional protection of a SARA designation, but have the potential to occur in Cape Breton:

- Striped bass [Inner Bay of Fundy Population or IBoF] (*Marone saxatilis*) – listed as “Threatened”
- American eel (*Anguilla rostrata*) – listed as “Special Concern”
- Atlantic salmon [Eastern Cape Breton Population] – listed as “Endangered”

Species listed by COSEWIC have the potential to receive SARA designation (and therefore protection) in the future. Therefore, it is important to recognize potential interactions between COSEWIC species of conservation concern and Project activities.

Striped bass are not known to inhabit the watersheds associated with this Project, and as such, their listing by COSEWIC does not affect the current assessment. American eel have been confirmed to inhabit watercourses along the transmission line route and have the potential to inhabit Schooner Pond along with tributaries feeding the pond. Atlantic salmon also have the potential to inhabit watercourses both on the Donkin Peninsula and along the transmission line route. Therefore, both species are discussed in greater detail below.

American Eel

The American eel has a wide distribution on the western side of the Atlantic Ocean from Venezuela to Greenland and Iceland, including the Sargasso Sea (southern North Atlantic). Its native Canadian range includes all freshwater, estuaries and coastal marine waters that are accessible to the Atlantic Ocean, from Niagara Falls in the Great Lakes up to the mid- Labrador coast.

A catadromous species, American eels spawn in the Sargasso Sea and eggs hatch within roughly one week. The larvae (leptocephali) are passively, but widely, dispersed by surface currents of the Gulf Stream system to western shores of the Atlantic Ocean. When larvae reach 55 to 65 mm long, they metamorphose into “glass eels”, a post-larval stage characterized by a lack of pigment. As they approach coastal estuaries, they become pigmented or “elvers”. This stage lasts 3 to 12 months during which they may migrate up rivers or remain in brackish or salt waters eventually becoming “yellow eels” (DFO 2010b). The yellow stage marks the growth phase where the skin thickens and sexual differentiation occurs. Between 8 and 23 years are required for individuals to become “silver eels”, at which time they are physically and physiologically adapted to migrate the thousands of kilometres back to their spawning grounds (COSEWIC 2006a).

The American eel is faced with a number of threats. Climate change may be causing a deviation of the Gulf Stream system to the north, which could interfere with larval transport to coastal areas. Dams and other barriers result in habitat loss and fragmentation and contribute to reduced or delayed recruitment. Biological (exotic species, parasites) and chemical contaminants, and commercial fishing are threats in some regions (COSEWIC 2006a).

American eel were observed in two streams along the transmission line corridor (Streams #10 and #19). Additionally, American eel have the potential to inhabit other water bodies on the Donkin Peninsula and along the transmission line route.

Atlantic Salmon (Eastern Cape Breton Population)

The Atlantic salmon once occurred in every country in which rivers flowed into the North Atlantic Ocean and the Baltic Sea. In North America the anadromous Atlantic salmon has inhabited rivers ranging from the Hudson River in New York northwards to the outer Ungava Bay in Quebec. The Canadian Range is estimated to be one third the area of the global population, ranging from the St. Croix River, bordering Maine and New Brunswick, to the outer Ungava Bay in Quebec as well as one population in Hudson Bay. This range includes approximately 700 rivers, not including many small tributaries in the area. The Eastern Cape Breton Population ranges from the Northern tip of Cape Breton Island (60° 35’ W, 47° 03’,N) to the Northeastern tip of mainland Nova Scotia (61° 28’ W, 45° 21’ N) (COSEWIC 2010a).

Over the entire North American range, the Atlantic salmon return to rivers from their feeding and staging areas at sea mainly between May and November, with some runs beginning as early as March and April. The timing of runs can vary according to the river, sea age, year, and hydrological conditions. Reproduction begins with the deposition of eggs into gravel bottom nests (redds) by females in October and November. Fertilization occurs with multiple males, of several life histories, competing for access to multiple females, leading to multiple paternities for each female’s offspring. The spawned out fish (kelts) either return to sea immediately or stay in freshwater until the following spring. The fertilized eggs remain and incubate in their nests over the winter months and begin to hatch in April. The young hatchlings (alevins) remain in their nest for several weeks feeding off of their yolk sac. By late May to June the yolk sac is fully absorbed and the free swimming fish (fry) being to feed on their own. The fry then turn to the parr stage and inhabit freshwater for 2-8 years, during which they undergo physiological and behavioral changes eventually migrating out to sea as smolt. The salmon generally spend one to two years at sea feeding and substantially growing in size before returning to their freshwater rivers to spawn (COSEWIC 2010a).

The Eastern Cape Breton Population of Atlantic salmon breeds in approximately 30 rivers that drain into the Atlantic Ocean and the Bras d’Or lakes. As a result, there is a potential for the species to be present in freshwater systems on the Donkin Peninsula (*i.e.*, Schooner Pond and tributaries) and in watercourses crossed by the transmission line route. The numbers of returning spawning adults in the Eastern Cape Breton population has declined by approximately 29 percent over the last three generations, in addition to declining numbers from previous generations. It is believed that the population of mature adults in the five rivers (North River, Baddeck Estuary, Clyburn River, Grand River, and Middle (Victoria Co.) Estuary) that hold the majority of the population was approximately 1150 when measured in 2008. There is not a high likelihood of rescue for this population as its neighboring populations are genetically different, with the closest population to the south being greatly depleted. The main threat to survival seems to be poor marine survival rates, which is related to large, but incompletely understood changes to the marine ecosystem (COSEWIC 2010a).

Provincial Species of Conservation Concern

The NS ESA also offers regulatory protection to certain freshwater aquatic species. Species identified as seriously at risk of extinction in Nova Scotia are identified by a provincial status assessment process through the Nova Scotia Endangered Species Working Group. Once identified, they are protected under the NS ESA. The conservation and recovery of species assessed and legally listed under the NS ESA is coordinated by the Wildlife Division of the NSDNR. There is also a provincial General Status assessment process that serves as a first alert tool for identifying species in the province that are potentially at risk. Under this process, species are assigned to one of four categories that designate their population status in Nova

Scotia. These include “Secure”, “Sensitive”, “May be at Risk”, and “At Risk”. Although species assessed under this process are not granted legislative protection, the presence of species ranked as “Sensitive”, “May be at Risk” and “At Risk” is an indication of concern by provincial regulators.

Atlantic whitefish (described above in Species at Risk) is the only species of freshwater fish listed under the NS ESA. The species is not known to inhabit waters on the Donkin Peninsula or along the transmission line corridor; therefore, its listing under the provincial Act does not affect the current assessment.

Other freshwater fish species found, or anticipated, to inhabit water bodies on the Donkin Peninsula or along the transmission line route have also been given various at-risk designations provincially. These include Atlantic salmon, brook trout (*Salvelinus fontinalis*), alewife (*Alosa pseudoharengus*) and striped bass. Atlantic salmon and striped bass are listed by NSDNR as “Red”, indicating that they are known to be or thought to be “At Risk”. ACCDC considers striped bass to be globally widespread and abundant but locally extremely rare and may be especially vulnerable to extirpation. ACCDC considers Atlantic salmon to be globally widespread and abundant but locally rare with the potential to be vulnerable to extirpation due to rarity or other factors. Salmonids are generally considered a sensitive family of fish, indicative of good water quality in relation to pH, dissolved oxygen, and metals (or other contaminant) levels. Brook trout are also salmonids and as such are similarly sensitive to several environmental conditions. NSDNR lists brook trout as “Yellow”, or sensitive to human activities or natural events. Brook trout is not listed on federal or provincial lists of conservation concern. ACCDC considers brook trout to be globally widespread and abundant and locally widespread, fairly common, and apparently secure with many occurrences, but of long term concern. Alewife is listed as “Yellow” by NSDNR and described by ACCDC as globally and locally widespread and apparently secure with many occurrences, but of longer term concern.

5.6.2.2 Freshwater Fish Habitat

5.6.2.2.1 Donkin Peninsula

Natural Watercourses

Schooner Pond

Schooner Pond (Figure 5.6.1a) measures approximately 370 m x 200 m and is surrounded by Baileys Wetland (CBCL 2008). At the location measured by CBCL, the depth of the pond was recorded as less than 1.5 m. Schooner Pond Beach Road separates Schooner Pond from Schooner Pond Cove (marine environment), with two 1 m diameter culverts allowing overflow from the pond into the marine environment. The substrate in Schooner Pond was composed of 60 percent gravel, 35 percent cobble, and 10 percent sand, with most of its bank vegetation being composed of grasses and small shrubs. In July of 2006, Schooner Pond was sampled for fish species using minnow traps. Two species of fish were caught including banded killifish and ninespine stickleback (CBCL 2008). Historically, the pond was stocked by the Port Morien Wildlife Association on a regular basis in the spring and fall with brook trout; however, due to poor road conditions on Schooner Pond Beach Road, stocking has ceased (Kennedy, J., pers comm. 2012). No trout were caught during 2006 sampling, but it is believed they may have been residing in a cooler section of the pond (shaded banks) (CBCL 2008).

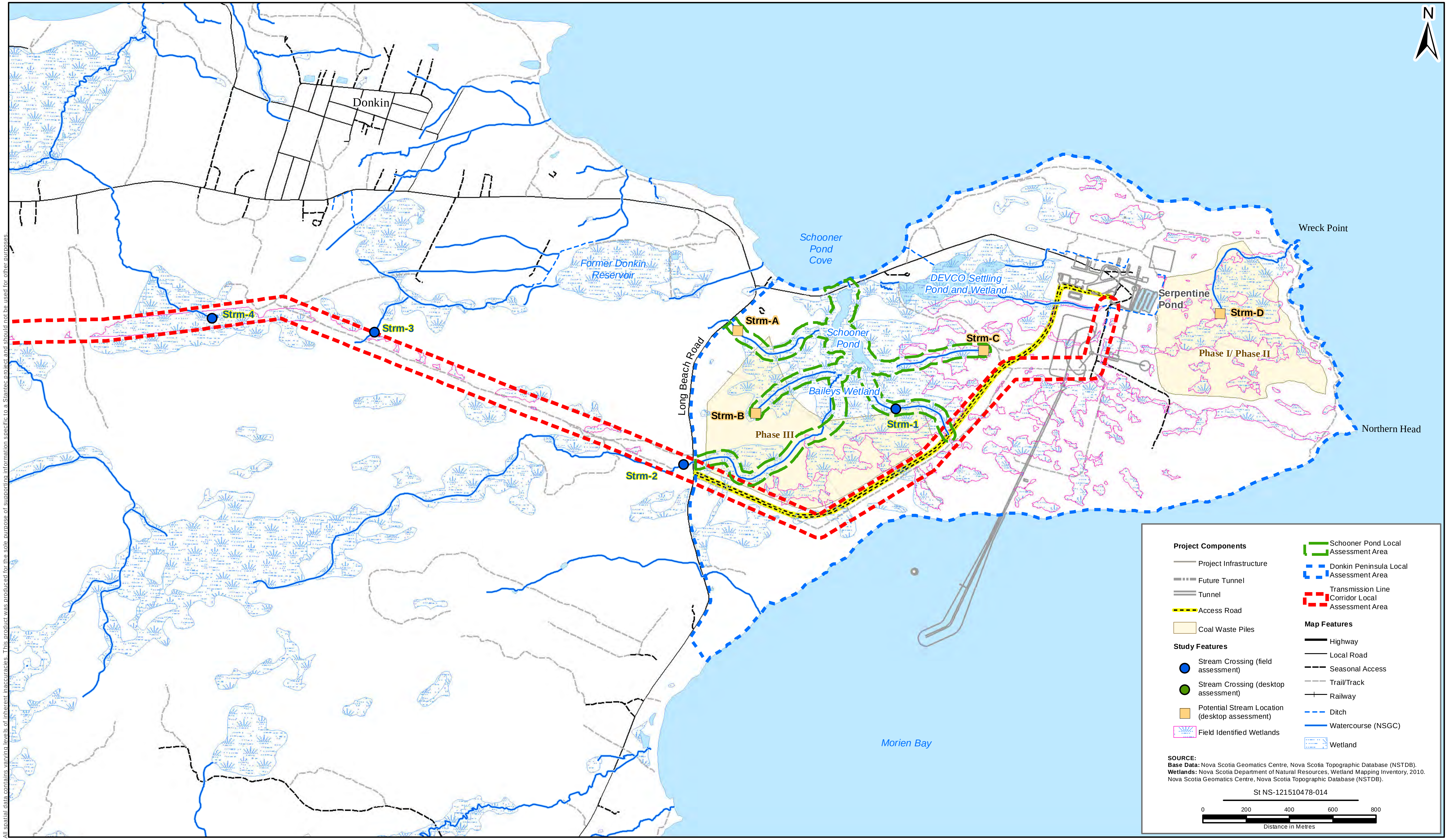
Stream 1

A narrow, intermittent stream flows from the southern end of the mine access road into Baileys Wetland in the center of the peninsula (Figure 5.6.1a). At the time of the survey, CBCL reported little to no flow in the channel, with the water ponding in depressions in the substrate in some areas. The streambed was composed of cobble and gravel embedded in sand. The streambanks appeared stable and vegetated with mixed coniferous and deciduous tree species. Overhanging streambank vegetation was low though canopy cover was high at 85 percent, indicative of a mature forest. A 50 m section of this watercourse was fished in 2008 with no fish observed or caught. The lack of a fish community in this reach of stream is likely due to the low water levels at the time of the survey, as the habitat within the stream could support fish including salmonids during higher flows (CBCL 2008). Table 5.6.3 lists the available habitat characteristics of Stream 1.

Stream 2

A wetland fed stream runs west to east adjacent to the transmission corridor right of way (Figure 5.6.1a). The unnamed perennial stream eventually feeds Schooner Pond. Within the area surveyed, the stream was approximately 1.25-1.74 m in width with an average depth of 15 cm and an entrenchment of 0.75 m. Substrate was predominately pebble with interspersed cobble; however, this larger substrate was embedded 35 percent and 50 percent with gravel and sand. The banks appeared to be stable and vegetated with undercutting observed throughout the assessment area. Stream bank vegetation varied from alders within the upstream section and cover diminished downstream where the riparian vegetation was mostly mosses and grasses in a coniferous forest. There are currently two small corrugated steel culverts on this stream passing under the Long Beach Road. The water at this location was tea-stained indicating high levels of tannins and lignins. Discharge during the assessment period was low and averaged 0.03 m^3/s. Table 5.6.3 lists the available habitat characteristics of Stream 2.

A fishing survey was carried out in Stream 2 by the Stantec Study Team. There were no fish caught, turned or observed. Electrofishing was completed at this water crossing in 2008 by CBCL with no fish caught.



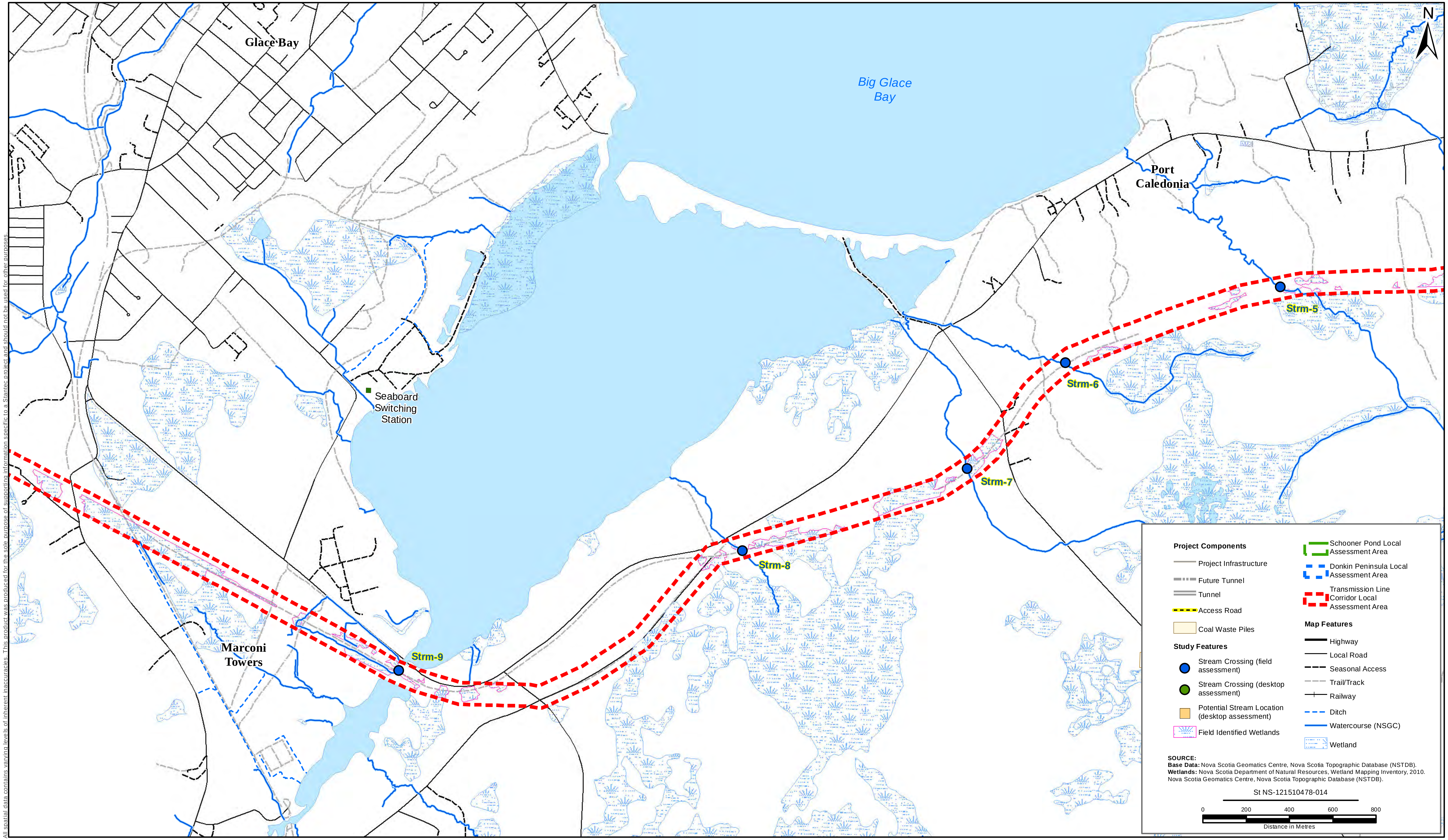
SOURCE:
Base Data: Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).
Wetlands: Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.
Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).

St NS-121510478-014

All spatial data contains varying levels of inherent inaccuracies. This product was produced for the sole purpose of supporting information specific to a Stantec project and should not be used for other purposes.

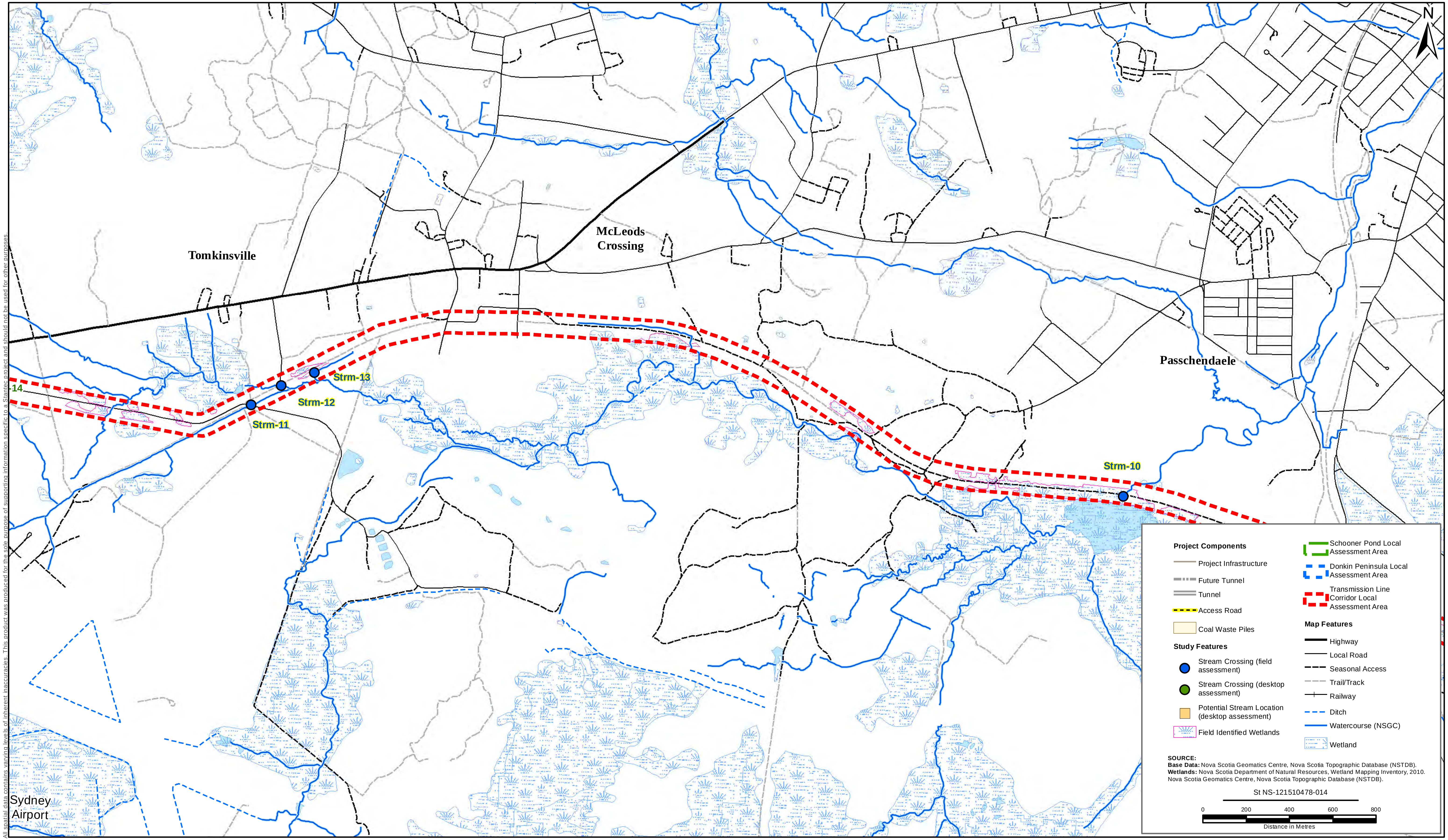
PREPARED BY: M. Huskins-Shupe	Donkin Export Coking Coal Project	FIGURE NO.: 5.6.1 a
REVIEWED BY: K Keizer		DATE: Apr 26, 2012
CLIENT: xstrata coal	**Watercourse Overview (Map 1 of 4)**	Stantec

File Path: V:\1215\active\121510xxx\121510478-Donkin Mine Enviro Assessment\geomatics\mapping\mxd\EA_Final\ST_NS_121510478_045_Watercourses_Mapbook_20120320.mxd



SOURCE:
Base Data: Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).
Wetlands: Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.
Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).

PREPARED BY: M. Huskins-Shupe	Donkin Export Coking Coal Project	FIGURE NO.: 5.6.1 b
REVIEWED BY: K Keizer		DATE: Apr 26, 2012
CLIENT: xstrata coal	**Watercourse Overview (Map 2 of 4)**	Stantec



SOURCE:
Base Data: Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).
Wetlands: Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.
Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).

PREPARED BY:
M. Huskins-Shupe

REVIEWED BY:
K Keizer

CLIENT:
xstrata coal

Donkin Export Coking Coal Project

Watercourse Overview (Map 3 of 4)

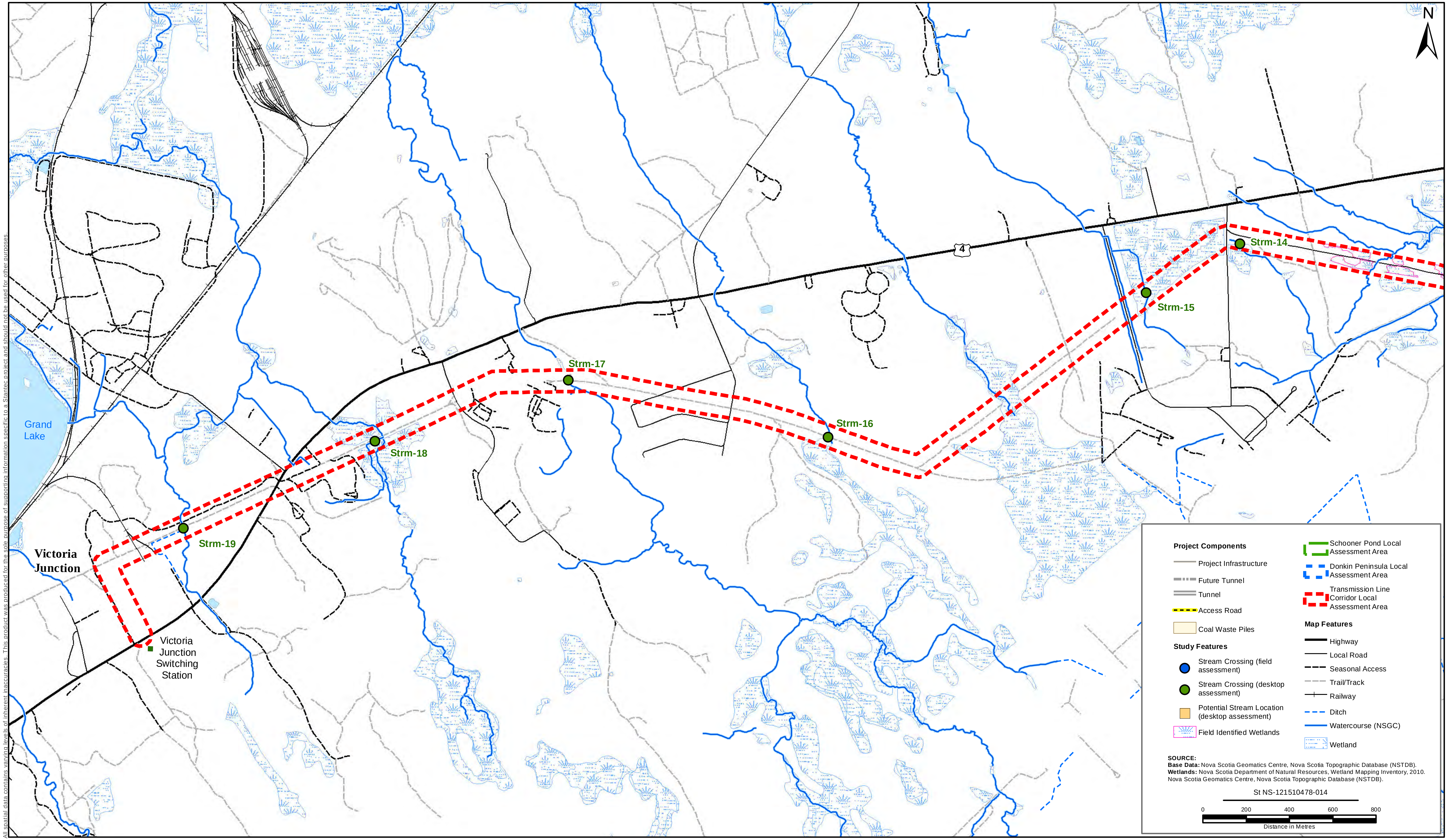
FIGURE NO.:
5.6.1 c

DATE:
Apr 26, 2012

Stantec

File Path: V:\1215\active\121510xxx\121510478-Donkin Mine Enviro Assessment\geomatics\mapping\mxd\EA_Final\ST_NS_121510478_045_Watercourses_Mapbook_20120320.mxd

All spatial data contains varying levels of inherent inaccuracies. This product was produced for the sole purpose of supporting information specific to a Stantec project and should not be used for other purposes.



SOURCE:
Base Data: Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).
Wetlands: Nova Scotia Department of Natural Resources, Wetland Mapping Inventory, 2010.
Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).

St NS-121510478-014

PREPARED BY: M. Huskins-Shupe	Donkin Export Coking Coal Project	FIGURE NO.: 5.6.1 d
REVIEWED BY: K Keizer		DATE: Apr 26, 2012
CLIENT: xstrata coal	**Watercourse Overview (Map 4 of 4)**	Stantec

File Path: V:\1215\active\121510xxx\121510478-Donkin Mine Enviro Assessment\geomatics\mapping\mxd\EA_Final\ST_NS_121510478_045_Watercourses_Mapbook_20120320.mxd

Streams A - D

There are four additional streams located on the Donkin Peninsula which have not been evaluated for fish or fish habitat: Streams A, B, C, and D (Figure 5.6.1a). Streams A, B and C flow into Schooner Pond. It is possible that these streams support freshwater fish habitat and fish, since multiple fish species have been identified in Schooner Pond. The habitat characteristics in these three watercourses are anticipated to be similar to the habitat observed in Stream 1. The fourth watercourse (Stream D) is located on the northeast tip of the peninsula and is surrounded by a wetland, which drains into the Atlantic Ocean. No fish habitat is anticipated within this stream because the Donkin Peninsula shoreline where the stream enters the Atlantic Ocean is composed of sandstone cliffs approximately 20 – 30 m in height; these cliffs create a barrier to fish passage. No field-based habitat assessments had been completed on these four streams at the time of writing.

Table 5.6.3 Fish Habitat and Species Information for Streams 1 and 2 Located on the Donkin Peninsula

				Bank Slopes		Bank Stability		Substrate (%)									Fish Results			
Stantec Field Reference Number	**Watercourse Name**	**Average Bankfull Width (m)**	**Average Depth (m) US-DS**	**Left (°)**	**Right (°)**	**Left**	**Right**	**Bedrock**	**Boulder**	**Lg. Cobble**	**Sm. Cobble**	**Lg. Pebble**	**Sm. Pebble**	**Gravel**	**Sand**	**Fines/Organics**	**Scientific Name**	**Common Name**	**Number Caught**	**Size Range (cm)**
-	Schooner Pond	Est. 200	>1	N/A	N/A	N/A	N/A	0	0	35	0	0	0	65	5	0	*Pungitius pungitius*	Ninespine stickleback	N/A	N/A
																	Fundulus diaphanous	Banded killifish	N/A	N/A
Strm – 1	Unnamed Trib to Schooner Pond	N/A	N/A	N/A	N/A	N/A	N/A	0	0	30	30	0	0	15	25	0	No Fish Present	-	0	N/A
Strm – 2[1]	Unnamed Trib to Schooner Pond	1.25-1.74	0.13-0.15	0-5	0-5	🟨	🟨	0	0	5	10	20	30	15	15	0	No Fish Present	-	0	N/A

Stable	🟩
Bare Stable	🟨
Eroding	🟥

[1] Electrofishing was carried out as far as access and water depth allowed within the 100 m assessment zone on the downstream side of the transportation corridor ensuring that all habitat types present were fished. If fish were caught within this assessment area, the distance fished was dependent upon the frequency of fish catch, the diversity of the species, and the stream conditions. A fishing survey was only completed on the upstream side of the transportation corridor when fish were not caught on the downstream side or if a different habitat or flow type was observed than had been fished on the downstream side.

CBCL 2008 and Stantec field studies.

Anthropogenic Freshwater Systems

Serpentine Pond

The serpentine pond (Figure 5.6.1a) was designed as part of the water treatment system used to treat the water from mine dewatering. It is anticipated that this canal will be retained and integrated into the water treatment system for the production phase of development. The Port Morien Wildlife Association (PMWA) stocked the serpentine pond with brook trout to monitor water quality in the past. The assumption was that if trout could survive in the waters of the serpentine pond, then any runoff from the pond would be safe for downstream fish habitat (J. Kennedy, PMWA, pers. comm. 2012). Additionally, surface water quality is currently being monitored throughout the passive treatment system, as part of the Care and Maintenance mode of operation on the Project site. The intent of the water monitoring and sampling program is to demonstrate, through analytical and other results, that current Project activities do not result in adverse effects to the surrounding aquatic environment. The results also supplement the existing environmental quality database, which includes baseline water quality data, and facilitate further analysis as the Project moves towards exploration and subsequent phases.

DEVCO Settling Pond

Historically, the DEVCO settling pond (Figure 5.6.1a) was stocked with brook trout, but due to accessibility issues stocking has since ceased (J. Kennedy, PMWA, pers. comm., 2012). In July of 2006 the settling pond was also sampled for fish species using minnow traps (CBCL 2008). Two species of fish were caught in the settling pond, which were also found in Schooner Pond: banded killifish and ninespine stickleback.

Anthropogenic Channels

Two channels were identified on the 1:10,000 scale mapping. One of the channels connects the serpentine pond canal to the DEVCO settling pond (Figure 5.6.1a).This channel was observed to run between two former waste rock disposal areas (CBCL 2008). The water in this channel flowed over a gravel/rock substrate with abundant instream vegetation (CBCL 2008).

The second channel observed originates from the old Mine access road, though intermittent sections may be found upstream of this location (Figure 5.6.1a). This channel appears to receive drainage from north of the PDA and flow into the DEVCO settling pond (CBCL 2008).

5.6.2.2.2 Transmission Line Corridor

Natural Watercourses

Streams 1 and 2, located on the Donkin Peninsula, will be crossed by the transmission line and have been described under Section 5.6.2.2.1 (Natural Watercourses) above. Watercourses 3 to 13 (Figure 5.6.1b & c) were assessed using the methods described in Section 5.6.2, at the location of proposed transmission line crossing. The results of the habitat assessment have been summarized in Table 5.6.4, below.

Watercourses 15 to 19 (Figure 5.6.1d) were assessed during early Project planning for a potential rail transportation corridor which was ultimately not selected for the Donkin Project. This corridor coincided with a majority of the general route of the proposed transmission corridor. The fish habitat assessments conducted for watercourses 15 to 19 were not conducted within the location of the transmission crossing but instead were situated between 0.8 and 2.8 km downstream of the proposed crossing. As such, the physical features of these four watercourses have not been assessed at the proposed crossing locations and are not included in the fish habitat summary table (Table 5.6.4).

Table 5.6.4 Fish Habitat and Species Information for Streams 3 through 13 Located Within the Transmission Line Route/Corridor

Stantec Field Reference Number[1]	Watercourse Name	Average Bankfill (m)	Average Depth (m) US-DS	Bank Slopes		Bank Stability		Watercourse Crossing Structure	Substrate (%)									Fish Results		Number Caught	Size Range (cm)
				Left (°)	Right (°)	Left	Right		Bedrock	Boulder	Lg. Cobble	Sm. Cobble	Lg. Pebble	Sm. Pebble	Gravel	Sand	Fines/Organics	Scientific Name	Common Name		
Strm – 3	Unnamed	No channel present		0 – 3	0 – 3	🟩	🟩	None	0	0	0	0	0	0	0	0	100	Not Fished - due to low water levels		0	N/A
Strm – 4	Unnamed	0.51	0.17	0 – 1	0 – 1	🟩	🟩	None	0	0	0	0	0	0	0	0	100	Not Fished - due to low water levels		0	N/A
Strm – 5	Doctor's Brook	2.35	0.41 – 0.20	20	4 – 5	🟩	🟩	Derelict Bridge	0	0	10	5	5	40	35	5	0	Not Fished - Salmonid Species Anticipated based on Habitat		0	N/A
Strm – 6	Unnamed	1.43-1.47	0.12 – 0.10	20 – 30	5 – 15	🟩	🟩	Timber Culvert	0	2	3	10	30	40	15	0	0	Not Fished - Salmonid Species Anticipated based on Habitat		0	N/A
Strm – 7	Blackwater Brook	1.25-2.53	0.09 – 0.15	2	0	🟩	🟩	None	0	2	3	65	15	5	5	5	0	Not Fished - Salmonid Species Anticipated based on Habitat		0	N/A
Strm – 8	Unnamed	2.31	Dry – 0.05	2 – 10	0 -2	🟨	🟨	Steel Culvert	0	2	50	30	10	5	3	0	0	Not Fished - Salmonid Species Anticipated based on Habitat		0	N/A
Strm – 9	Big Glace Bay Lake	80	1.5	N/A[1]	N/A[1]	🟩	🟩	Abutments	0	5	50	20	0	0	10	15	0	*Apeltes quadracus*	fourspine stickleback	3	3.9-4.8
																		Fundulus heteroclitus	mummichog	3	3.8-4.4
																		Cancer sp.	rock crab	11	N/A
																		Cambaridae fam.	crayfish	13	N/A
Strm – 10	Renwick Brook	3.57-5.4	0.65 – 0.25	0 – 5	0	🟥	🟥	Twin Steel Culverts	0	0	50	30	0	10	10	0	0	*Pungitius pungitius*	ninespine stickleback	4	3.3-4.6
																		Anguilla rostrata	Americanl eel	1	35
																		Salvenlinus fontinalis	brook trout	N/A	N/A
Strm – 11	Renwick Brook	1.0-3.72	0.24 – 0.10	5 – 45	5 – 45	🟩	🟩	Steel Culvert	5	20	20	20	20	15	0	0	0	Not Fished - Stream will not be Affected by Project		N/A	N/A
Strm – 12	Trib. To Renwick Brook	1.94-2.38	0.09 – 0.05	10-Jan	10 – 30	🟥	🟥	Derelict Bridge	0	0	30	20	20	10	10	10	0	Not fished in 2011/Fry present in 2008		N/A	N/A
Strm – 13	Trib. To Renwick Brook	5.41	Dry – 0.17	20	0	🟩	🟩	None	0	0	0	0	0	0	0	0	100	Not Fished - due to dry streambed		N/A	N/A

Stable	🟩
Bare Stable	🟨
Eroding	🟥

[1] Electrofishing was carried out as far as access and water depth allowed within the 100 m assessment zone on the downstream side of the transportation corridor ensuring that all habitat types present were fished. If fish were caught within this assessment area, the distance fished was dependent upon the frequency of fish catch, the diversity of the species, and the stream conditions. A fishing survey was only completed on the upstream side of the transportation corridor when fish were not caught on the downstream side or if a different habitat or flow type was observed than had been fished on the downstream side.

A summary of active spawning times for all freshwater fish caught within the transmission corridor LAA and Schooner Pond LAA is included in Table 5.6.5.

Table 5.6.5 Summary of Spawning Times for all Fish Caught Within the Schooner Pond and Transmission Corridor LAAs

Scientific Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Anguilla rostrata	American eel					1			2	2			
Apeltes quadracus	Fourspine stickleback					🟥	🟥 🟨	🟥 🟨					
Fundulus diaphanus	Banded killifish					🟥 🟨	🟥 🟨						
Fundulus heteroclitus	Mummichog						🟥	🟥 🟨	🟨				
Pungitius pungitius	Ninespine stickleback						🟥	🟥 🟨	🟨				
Salvelinus fontinalus	Brook trout	🟨	🟨							🟥	🟥	🟥	🟨

1 Upstream migration of immature fish
2 Downstream migration of mature spawners
🟥 Spawning
🟨 Eggs/Sacfry in substrate

Scott and Crossman 1998

5.6.2.3 Surface Water Quality

Within the Freshwater Fish and Fish Habitat VEC, water quality is discussed as it relates to the chemical characteristics (pH, temperature and dissolved oxygen) required for fish habitat. Further discussion of surface water chemistry and the interaction with the Project during construction, operation and maintenance, and decommissioning and reclamation is included in the Water Resources VEC (Section 5.2).

Low pH or acidic waters are common to the rivers of Cape Breton, Nova Scotia due to acidification from rain as well as bedrock geology (MacPhail *et al.* 1987). Acidification can be caused by a variety of factors including influences from wetlands, naturally occurring organic acids and geological sources (CCME 2009), as well as anthropogenic effects. The Canadian Council for the Ministers of Environment (CCME) created water quality guidelines for the protection of Freshwater Aquatic Life (CCME FWAL). These guidelines establish a range of pH from 6.5 to 9.0 suitable for freshwater habitat.

The two major sources of dissolved oxygen in water are the atmosphere and the photosynthesis of aquatic vegetation. The balance between the input of oxygen and consumptive metabolism of organisms and oxidizable matter received serves to control the dissolved oxygen content in the water (CCME 2007). The concentration of dissolved oxygen in a watercourse also depends on a number of independent variables that include surface and interstitial water velocity/discharge, hydraulic gradient, sediment texture and porosity, bottom morphology, daily water temperature fluctuation, and the consumptive oxygen demand of the substrate (CCME 2007).

CCME established a guideline for dissolved oxygen concentration in freshwater through the Canadian Water Quality Guidelines for the protection of freshwater aquatic life (CCME FWAL). This guideline establishes a minimum recommended concentration of dissolved oxygen of 6.5 mg/L for adult lifestages of cold water biota (such as salmonids) and 9.5 mg/L for juvenile lifestages. Seven of the nineteen watercourses within the transmission corridor and Schooner Pond LAAs fell below the recommended concentration of dissolved oxygen for adult lifestages of cold water biota, while fourteen watercourses were below the recommended concentrations for juvenile lifestages on the date sampled. Dissolved oxygen concentration is expected to vary seasonally throughout the year with changes in water temperature and discharge rate.

5.6.2.3.1 Donkin Peninsula

Water quality within the Donkin Peninsula was measured during the CBCL field surveys in July 2008 for Schooner Pond and Stream 1. Stream 2 water quality was measured *in situ* in August 2010 by the Stantec Study Team. (See Figure 5.6.1a) for an illustration of the locations of Schooner Pond, Stream 1 and Stream 2.

Natural Watercourses

Schooner Pond, Streams 1 and 2

Schooner Pond can be considered a eutrophic system based on the low (0.7ug/L) concentration of total phosphorus found in its water at the time it was surveyed (CBCL 2008). The water was well oxygenated and slightly acidic, making the pond suitable habitat for brook trout. Although none were found during the fish surveying, their absence was likely due to high water temperatures at the sampling location. Stream 1 drains into Schooner Pond and is a moderately acidic stream at 5.00; this pH level falls outside the range recommended by CCME for the support of freshwater aquatic life. However, survival of multiple fish species in water of this pH is possible and has been observed in many areas of Nova Scotia. Sensitive species such as salmonids may avoid such acidic conditions. The dissolved oxygen concentrations in Stream 1 are also moderate at 6.87 mg/L, which is slightly above the CCME guidelines for adult lifestages.

Acidic conditions were also observed in Stream 2.The pH level was measured at 3.80 during the survey. When pH levels decrease, brook trout and Atlantic salmon populations have also been shown to decrease. A study from DFO (2003) indicated that of 100 streams and brooks surveyed in Nova Scotia, none of the watercourses with pH levels less than 5.4 contained brook trout or Atlantic salmon.

A summary of water quality parameters for Schooner Pond, Stream 1, and 2 (see Figure 5.6.1a) can be found below in Table 5.6.6.

Table 5.6.6 Summary of Water Quality Parameters for Watercourses on the Donkin Peninsula

Stantec Field Reference Number	Watercourse Name	Water Temp. (C°)	pH	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Discharge (m^3/s)
-	Schooner Pond	21.7	6.55	190	7.84	N/A	N/A
Strm – 1	Unnamed	17.6	5.00	129	6.87	N/A	N/A
Strm – 2	Unnamed	18.08	3.80	81	10.59	112	0.0034

CBCL 2008.

Anthropogenic Freshwater Systems

Serpentine Pond and DEVCO Settling Pond

No water quality measurements were taken within the serpentine pond canal during the CBCL or Stantec fish habitat assessments; however, surface water quality data has been collected for the environmental water monitoring program. The Port Morien Wildlife Association introduced brook trout into the serpentine pond and the fish survived for extended period of time (*i.e.*, multiple seasons at a minimum) (J. Kennedy, PMWA, pers. comm. 2012). As a result, it can be inferred that the water quality and dissolved oxygen within the serpentine pond are sufficient to sustain aquatic life, including relatively sensitive groups (*e.g.*, salmonids). Toxicity testing has been completed as part of the environmental water monitoring program currently being carried out on site. Toxicity has been tested at the outflow of the DEVCO settling pond, prior to it entering the marine environment. There was no fish mortality in any of the four toxicity testing periods conducted in 2011 and therefore results passed Environment Canada’s acute lethality test criteria of less than 50 percent fish mortality during the 96-hour period in 100 percent of the water sample (Reference Method EPS 1/RM/13).

The DEVCO settling pond can be considered a eutrophic system based on the low concentration of total phosphorus (0.6 ug/L) found in its water (CBCL 2008). Water quality was measured during the CBCL field surveys (July 2008). The pH of the DEVCO settling pond was slightly acidic at 6.55; this pH level is within the recommended range established by CCME for freshwater habitat. A low dissolved oxygen concentration of 4.95 mg/L was measured during the surveys; this level of dissolved oxygen is below the recommended concentration for juvenile and adult coldwater species, though the concentration is likely not lethal (CCME 2007). The water temperature was 24.8 °C in the DEVCO settling pond at the time of the CBCL survey (2008), while the specific conductivity was 2,800 uS/cm.

The locations of the serpentine pond canal and the DEVCO settling pond are illustrated in Figure 5.6.1a.

5.6.2.3.2 Transmission Line Corridor

Natural Watercourses

Water quality within the freshwater systems located on the transmission line route (*i.e.,* Watercourses 3 to 19; 16 watercourses in total) was measured during the Stantec August 2010 surveys. Within Watercourses 3 to 13 (Figure 5.6.1b & c), the water quality was measured at the point where the existing transmission line corridor crossed the watercourse. Water quality was not measured in Watercourse 14 since this site was not visited during the survey. Within Watercourses 15 to 19 (Figure 5.6.1a-d), water quality was measured between 0.8 km and 2.8 km downstream of the crossing location (*i.e.,* at the location of the previously proposed rail corridor). Therefore the water quality listed in Table 5.6.7 for watercourses 15 to 19 represents a qualitative assessment of the potential water quality within the watercourse as it relates to fish habitat within the watercourse.

Dissolved oxygen concentrations were below CCME FWAL guidelines for juvenile cold water species at 13 of 16 watercourses and below CCME FWAL for adult cold water species at 6 of 16 watercourses. The lowest dissolved oxygen concentrations were located at Streams 3 and 13; this corresponds to the substrate type, water velocity, and several other habitat characteristics observed in these streams. Both streambeds were dominated by organic matter and fines (silt, sand and clay); this fine substrate matter enables growth of microbes and fauna within the sediment which contributes to oxygen depletion at the sediment-water interface. The stagnant nature of both watercourses impedes water column mixing and minimizes the transfer of atmospheric oxygen to the top of the water column. The highest dissolved oxygen concentrations observed were associated with tidally influenced waters (Big Glace Bay Lake), and larger streams and rivers with hard streambed substrate and higher velocities (Renwick Brook).

Within the watercourses located along the transmission line, pH levels varied from 3.74 to 8.05, with the highest pH level being observed in the estuarine conditions of Big Glace Bay Lake. Generally, lower pH (more acidic) levels were observed in the watercourses in closest proximity to the Donkin Peninsula. Watercourses became less acidic to the west of Big Glace Bay Lake. This change in acidity is likely due to soil composition and other natural geologic factors. For instance, rock with high (>0.30 percent) sulphur content has been sampled within the Donkin Peninsula. High levels of sulpide bearing rock leads to the acidification of surface waters through the oxidation of sulphur into sulphuric acid. This natural reaction occurs through the weathering of rock but is augmented through excavation, mining, blasting or any operation which exposes this sulphide bearing material to air and water.

A summary of the water quality measured in August 2010 during the Stantec field surveys is listed in Table 5.6.7 (see Figure 5.6.1b, c & d for illustrations of the stream locations). Streams 15-19 were sampled between 0.8 and 2.8 km downstream of the proposed crossing location. However, unlike the physical habitat features which are specific to the crossing location, it is anticipated that water quality would be comparable to the crossing location and therefore these streams are included in the table.

Table 5.6.7 Summary of the Water Quality Parameters for Streams 3 through 13 and 15 through 19 Located Within the Transmission Line Corridor

Stantec Field Reference Number	Watercourse Name	Water Temp. (°C)	pH	Specific Conductivity (µs/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Discharge (m^3/s)
Strm – 3	Unnamed	17.48	4.71	118	1.71	17.8	ND
Strm – 4	Unnamed	24.29	3.74	91	5.11	58.9	ND
Strm – 5	Doctor's Brook	18.09	4.37	75	5.25	56.2	0.08
Strm – 6	Unnamed	16.54	6.05	80	8.41	86.4	0.01
Strm – 7	Blackwater Brook	15.84	5.21	66	8.93	89.4	0.06
Strm – 8	Unnamed	16.38	3.75	69	4.49	76.4	0.03
Strm – 9	Big Glace Bay Lake	21.19	8.05	439181[1]	10.91	108.9	ND
Strm – 10	Renwick Brook	20.62	7.46	120	10.45	116	0.18
Strm – 11	Trib to Renwick Brook	22.26	7.25	211	8.76	114.4	0.01
Strm – 12	Trib to Renwick Brook	19.27	6.97	193	10.54	100.4	ND
Strm – 13	Trib to Renwick Brook	17.76	6.89	287	1.86	20	ND
Strm – 14	Unnamed	-	-	-	-	-	-
Strm – 15	Blackbottom Brook	16.52	6.91	401	6.92	70.9	0.00
Strm – 16	Unnamed	16.32	7.20	203	8.2	82.6	0.01
Strm – 17	Trib to Southwest Brook	16.42	7.09	145	6.24	63.9	0.01
Strm – 18	Southwest Brook	19.35	7.02	83	8.03	87.2	0.35
Strm – 19	Northwest Brook	24.96	6.79	211	3.62	43.8	0.33

[1] Salt water at this location caused higher specific conductivity.

5.6.3 Potential Project-VEC Interactions

Table 5.6.8 below lists each Project activity and physical work for the Project, and ranks each interaction as 0, 1, or 2 based on the level of interaction each activity or physical work will have with Freshwater Fish and Fish habitat.

Table 5.6.8 Potential Project Environmental Effects to Freshwater Fish and Fish Habitat

Project Activities and Physical Works	Potential Environmental Effects	
	Change in Fish Habitat	Change in Mortality Risk
Construction		
Site Preparation (incl. clearing, grading and excavation)	1	1
Construction of Mine Site Infrastructure and Underground Preparation	1	1
Construction of 138 kV Transmission Line	1	1
Construction of Barge Load-out Facility (incl. dredging, infilling and habitat compensation)	0	0
Installation of Transshipment Mooring	0	0
Operation and Maintenance		
Underground Mining	0	0
Coal Handling and Preparation (incl. coal washing and conveyance)	1	1
Water Treatment (incl. mine water and surface runoff)	2	2
Coal and Waste Rock Disposal	2	2
Marine Loading and Transportation	0	0
Coal Trucking	1	1
Decommissioning and Reclamation		
Site Decommissioning	1	1
Site Reclamation	1	1

0 = No interaction
1 = Interaction occurs; however, based on past experience and professional judgment, the resulting effect can be managed to acceptable levels through standard operating practices and/or through the application of best management or codified practices. No further assessment is warranted.
2 = Interaction occurs, and resulting effect may exceed acceptable levels without implementation of specified mitigation. Further assessment is warranted.

Several of the Project activities and physical works avoid freshwater resources and consequently do not interact with the Freshwater Fish and Fish Habitat VEC, resulting in a ranking of 0 in Table 5.6.8. During the construction phase of the Project, two activities are marine-based: construction of the barge load-out facility; and installation of the transshipment mooring station. The barge load-out facility and the transshipment mooring station are located in the marine environment; therefore, they do not interact with freshwater resources on the

Donkin Peninsula. Similarly, during the operation and maintenance phase of the Project, two activities avoid interaction with the freshwater environment: underground mining; and marine loading and transportation. Since the underground mining as well as the marine loading and transportation activities occur in (or under) the marine environment, neither activity has the opportunity to interact with freshwater resources located on the Donkin Peninsula. Given the lack of interaction between the Freshwater Fish and Fish Habitat VEC and these four Project activities, all four interactions receive a ranking of 0 for potential environmental effects.

All three Project phases contain activities that will interact with either natural or anthropogenic freshwater resources on the Donkin Peninsula or along the transmission line route. The majority of these activities will not result in a significant environment effect due to numerous opportunities to mitigate effects through the application of best management practices. Activities for which potential environmental effects can be mitigated to an acceptable level during interactions with the Freshwater Fish and Fish Habitat VEC have been ranked 1 (Table 5.6.8). During the construction phase of the Project, three activities will interact with freshwater resources resulting in potential environmental effects ranked as 1; these include: site preparation (including clearing, grading and excavation); construction of the mine site infrastructure and underground preparation; and construction of the transmission line.

All site preparation activities and the activities associated with the mine infrastructure construction occur on the Donkin Peninsula. With the exception of site preparation for coal waste stockpiling which will occur on a progressive basis during operations, none of these activities occur in close proximity to natural freshwater water bodies (see Figure 5.6.1a); therefore, direct interactions and the associated effects are not anticipated. The site preparation and mine infrastructure construction activities could have potential indirect effects on the natural freshwater watercourses located on the Donkin Peninsula through sedimentation, resulting in a ranking of 1 for these activities. Further, there is potential for erosion and sedimentation along the mine site access road resulting from the construction phase road traffic, which could affect Streams 1 and 2 (see Figure 5.6.1). Erosion and sedimentation can occur whenever soil is exposed. Sedimentation (increased sediment load in stream water and deposition in downstream sediments) is perhaps the most common environmental effect of construction activities on fish and fish habitat. The severity of erosion and sediment transport depends on several factors, including precipitation, soil type, slope, vegetation cover, distance to a watercourse, and season. In general, fine-grained clay-silt materials situated on steep slopes are of greatest concern.

The environmental effects of sedimentation are well studied and understood. Anderson *et al.* (1996) and Trow Consulting Engineers Ltd. (1996) summarized the potential environmental effects of sedimentation and siltation on fish habitat as follows:

- Changes in stream morphology and stream bed porosity leading to degradation of spawning substrates, holding pools, instream cover and foraging habitat;

- Reduced diversity and abundance of bottom dwelling fish food organisms; and
- Destruction of aquatic vegetation that is buried by sediments.

The potential direct environmental effects of sedimentation on fish include the following:

- First-level behavioural responses, usually temporary, and not resulting in a change in health;
- Minor physiological influences where fish and benthic invertebrates may avoid exposure but there may be environmental effects to health due to exposure or reduction in food supply;
- Physiological changes due to long-term exposure affecting life stages or feeding; and
- Environmental effects on eggs and larvae which cannot avoid areas of exposure.

Two anthropogenic freshwater systems are located in the vicinity of site preparation and mine infrastructure construction activities: the serpentine pond canal and the DEVCO settling pond. While both of these systems have supported brook trout in the past (see Section 5.6.2), neither is considered a natural watercourse (NSE 2012b) and consequently do not fall under regulatory protection. Nevertheless, these anthropogenic water features will benefit from the implementation of sediment and erosion control planning on the mine site during the construction phase.

A total of nineteen watercourses are anticipated to be crossed by the transmission line route from the mine site to Victoria Junction (see Figure 5.6.1). Nine of these watercourses (Streams 1 to 9) fall along a currently inactive transmission line corridor, while the remaining ten streams (Streams 10 to 19) are located within an active transmission line corridor. A higher potential exists for an interaction between the transmission line construction phase activities and the watercourses located within the currently inactive transmission line corridor because clearing will be required to install the new poles and lines. No new clearing is planned for the active portion of the transmission line corridor; however new poles and lines will be required within the active portion of the corridor to upgrade the system to provide 138 kV power to the mine.

NSPI follows internal protocols designed to protect freshwater resources crossed by their transmission lines, including during clearing activities; therefore, potential environmental effects from transmission line construction activities are ranked as 1.Their freshwater protective measures include best management practices that focus on avoiding instream work, controlling sedimentation potential, and using temporary bridges for moving heavy equipment across streams (NSPI 2009). During all transmission line construction activities (with the exception of emergency situations), NSPI adheres to their environmental protection procedures, which are intended to confirm that RoW practices address relevant regulatory requirements (NSPI 2009). As a result of the freshwater protective measures put in place by NSPI during their transmission line construction activities, no significant adverse environmental effect is anticipated on fish and fish habitat located within the active or inactive portions of the transmission line corridor connecting the mine site to Victoria Junction. As such, this Project activity results in a 1 ranking in relation to potential effects on fish and fish habitat (Table 5.6.8)

Within the operation and maintenance phase of the Project, coal handling and preparation, including coal washing and conveyance, has been ranked as 1 in Table 5.6.8. This ranking has been given for the potential environmental effects resulting from these activities because various mitigations measures will be put in place to prevent the dispersion of coal dust into freshwater systems and on surface waters located on the Donkin Peninsula during the handling, preparation, washing and conveyance of coal (See Section 5.1, Atmospheric Resources). The mitigation measures include the use of closed conveyors, the erection of dust screens, and the use of sprayed water to manage dust dispersion, as needed. Given these various mitigative options, it is anticipated that dust dispersion can be controlled and kept out of the freshwater water environment during the handling, preparation, washing and conveyance of coal. As such, freshwater fish and fish habitat will be protected from significant adverse environmental effects from this specific operation and maintenance phase activity (*i.e.*, environmental effects ranked as 1 in Table 5.6.8).

Decommissioning and reclamation of the mine would see similar potential for 1 rankings between site activities and the freshwater environment as those discussed above for site preparation and mine site infrastructure construction phase activities. Decommissioning of the mine site infrastructure would not directly affect natural water courses on the Donkin Peninsula, but indirect effects could result from erosion and sedimentation run-off. Therefore, sediment and erosion control planning would manage potential effects to an acceptable level, resulting in an environmental effects ranking of 1 in Table 5.6.8). The anthropogenic freshwater systems on the site (*i.e.*, DEVCO settling pond and serpentine pond canal) are anticipated to be kept active indefinitely as part of the long term water treatment and monitoring on site. Site reclamation would be carried out progressively and would be designed to manage the drainage, stability and erosion effects on freshwater resources, including Schooner Pond and its tributaries. As such, fish and fish habitat would be protected from negative interactions with the coal and waste rock disposal systems during reclamation activities.

Thus, in consideration of the nature of the interactions and the planned implementation of known and proven mitigation, the potential environmental effects of all Project activities and physical works that were ranked as 0 or 1 in Table 5.6.8, on freshwater fish and fish habitat during any phase of the Project are rated not significant, and are not considered further in the assessment. The two remaining Project activities not discussed above result in the potential for adverse environmental effects on freshwater fish and fish habitat and have been ranked as 2. The two activities occur during the operation and maintenance phase of the Project: water treatment (including mine water and surface runoff) and coal and waste rock disposal.

Water treatment has the potential for level 2 environmental effects on fish and fish habitat through the potential acidification of natural freshwater systems resulting from coal waste disposal pile run-off. Coal waste is known to be acid generating in nature; therefore, the runoff from the land-based coal waste disposal piles has the potential to change fish habitat through adverse effects on water quality. The land-based disposal of coal waste (including waste rock) will also result in the permanent infilling and diversion of multiple streams, resulting in an irreversible effect on fish habitat. Further discussion of these environmental effects is provided in Section 5.6.5.

5.6.4 Assessment of Project-Related Environmental Effects

A summary of the environmental effects assessment and prediction of residual environmental effects resulting from interactions ranked as 2 on freshwater fish and fish habitat is provided in Table 5.6.9. Only the interactions ranked as 2 were considered further in the assessment of Project related environmental effects. All other interactions previously ranked as 0 or 1 were rated as not significant.

The Project activities identified as having interactions ranked as 2 occur on the Donkin Peninsula, primarily within the Schooner Pond LAA. The transmission line LAA does not include any level 2 ranked Project activity interactions. As such, the following assessment of Project-related residual environmental effects is focused on the Schooner Pond LAA, with reference to the Donkin Peninsula LAA when appropriate.

5.6.4.1 Assessment of Change in Fish Habitat

5.6.4.1.1 Potential Environmental Effects

During the operation and maintenance phase of the Project, coal reject and waste rock will be disposed of on the Donkin Peninsula, resulting in direct interactions with freshwater fish habitat. Also, the run-off associated with the coal waste disposal piles has the potential to result in direct and indirect effects on freshwater resources, particularly in the Schooner Pond LAA. Treatment systems will be established on the mine site to address potential effects associated with coal waste pile run-off as well as mine dewatering during the operation and maintenance phase of the Project. The water treatment systems also have the potential to result in effects on freshwater fish and fish habitat. These Project activities have been determined to have interactions ranked as 2 in the assessment (Table 5.6.8) and fall within the operation and maintenance phase; therefore, the interactions will span the life of operations at the mine and will extend into the decommissioning and reclamation phase.

Figure 5.6.1a illustrates the two planned coal waste pile locations on the Donkin Peninsula. The disposal pile located within the Donkin Peninsula LAA is found on the eastern portion of the peninsula and will be used first, during Phase I and Phase II of mine operations. It is anticipated to take approximately 13 years to exhaust the disposal potential at this site. The Phase I/II disposal pile will directly affect the single watercourse (Stream D) known to drain from this area by covering the stream for the majority of its reach. However, Stream D does not support fish or fish habitat. The shoreline at the location of the stream’s input into the Atlantic Ocean is dominated by steep cliffs. The elevation of the cliffs presents a known barrier to fish passage;

therefore, Steam D is not considered a fish-bearing stream and Project activities will not interact with fish habitat in Stream D. The in-filling of the stream is anticipated to qualify as a watercourse alteration, requiring a (Division 1) Water Approval by NSE under the Nova Scotia *Environment Act* and the Activities Designation Regulations post EA approval but prior to the start of disposal activities. The water carried by Stream D enters the marine environment, resulting in the need to consider Project activity effects on the water quality and quantity of the stream.

The second coal waste pile, located to the southwest of Schooner Pond, is planned for operation approximately 13 years after the start of mining. This Phase III disposal pile directly affects the Schooner Pond LAA, which is comprised of the pond itself and the multiple watercourses that feed Schooner Pond via Baileys Wetland (see Figure 5.6.1, Streams A – C and Streams 1-2). There are three types of potential stream interactions based on the currently proposed disposal pile location and dimensions: 1) streams are subject to sedimentation resulting from the construction and operation and maintenance activities associated with the engineered disposal piles; 2) streams are subject to in-filling; and 3) streams are diverted to circumvent the disposal pile. Through these three Project interactions with the freshwater environment, changes in fish habitat would potentially result from adverse effects on several habitat components: loss in, or alteration of, habitat quality (*e.g.*, sedimentation) and quantity; change in drainage area and/or flow rate; fish passage obstruction; and change in overall water quality. Effects on fish habitat have the potential to occur for the duration of the use of the Phase III disposal pile location and may extend throughout the Schooner Pond LAA.

Coal waste disposal piles have the potential to cause acidification of nearby freshwater resources. Rainwater run-off and seepage from the disposal piles are the two primary means by which acidification of neighboring freshwater resources can transpire. The changes in fish habitat that can occur as a result of watershed acidification include changes in sediment and water chemistry, which can in turn affect the macrophyte and benthic invertebrate communities. Changes in these communities represent changes in the primary production component of fish habitat, which in turn can affect the remainder of the freshwater ecosystem.

A water treatment facility will be designed to treat water run-off associated with the coal waste disposal piles and to treat water removed from the mines. The existing passive treatment system discharges mine water to the serpentine pond canal to allow settling of particulate before the water makes its way to the DEVCO settling pond. From the settling pond, the wastewater discharges to the marine environment either directly or via a channel through Baileys Wetland. This passive system will continue to receive and treat (via settling) the mine waters. An active treatment system will be established to neutralize the acidic runoff from the coal waste disposal piles. Potential interactions between water treatment and freshwater fish habitat are primarily chemical. A chemical interaction could occur through changes in water quality (including potential acidification) within Schooner Pond if the new active treatment system results in acidic water discharging into Schooner Pond or its tributaries.

5.6.4.1.2 Mitigation of Project Environmental Effects

The primary mitigative action that will be taken to minimize Project interaction effects on freshwater fish habitat will be avoidance. The following avoidance-based mitigation measures will be employed during the operation and maintenance phase of the Project:

- Final design and configuration of the Phase III coal waste rock disposal pile will be undertaken to avoid Streams 1 and A (with a 30 m buffer) where feasible.
- Water treatment operations (including both mine water and waste rock disposal pile run-off water) will be designed and implemented to avoid direct interaction of untreated water with all natural watercourses on the Donkin Peninsula, including Schooner Pond and its tributaries. Additional mitigation detail specific to water treatment is provided in the Water Resources VEC (Section 5.2).
- Ancillary mining activities (*e.g.*, truck and equipment movements and road and utility construction) will avoid watercourses where feasible.

The disposal of coal and waste rock on the Phase III disposal pile and the resulting diversion or infilling of watercourses will result in the permanent destruction or alteration of fish habitat. The estimated net change in freshwater fish habitat (HADD) is 1059 m^2 (refer to Appendix G for habitat compensation plan). In addition to the direct effects on fish habitat within the two known streams affected by these Project activities, the primary potential indirect effects to fish habitat will be a result of erosion and sedimentation associated with the disposal activities. To minimize indirect environmental effects on fish habitat, erosion and sediment control measures will be employed as detailed below:

- Any watercourse crossings required during disposal activities will be properly sized and designed to facilitate watercourse flow and, in fish-bearing streams, to allow fish passage as per the criteria detailed in the DFO’s Design Criteria for Fish Passage in New or Retrofit Culverts in the Maritimes Provinces, Canada.
- The watercourse crossing structures will be inspected, cleaned and repaired on a regular basis, as required, to maintain normal water flows
- Infilling and diversion of streams will use clean rock.
- CCME guidelines stipulate that TSS must not increase by a level exceeding 25 mg/L over background levels during any short-term exposure period (*e.g.,* 24 hours), and must not exceed a maximum average increase of 5 mg/L from background levels for longer term exposure (*e.g.*, 24 hrs to 30 days) (CCME 2007).
- The Project will comply with NSE Conditions of Approval (*i.e.*, Division 1 Water Approval) which will stipulate specific monitoring requirements.

- Heavy machinery used during disposal activities will be kept a minimum of 10 m from the watercourse banks.

Erosion and sedimentation controls employed during operation and maintenance of the coal waste disposal piles will be designed and maintained in accordance with the NSE Erosion and Sedimentation Control Handbook (NSE 1988) and Watercourse Alteration Specifications (NSE 1997 and updates). Mitigation under these programs will focus on the following:

- Use of diversion berms to divert flow.
- Installation of erosion protection measures at the disposal pile outlets.
- Use of flow-checks in ditches, swales and chutes to reduce runoff velocity.

In addition, the following mitigation will be implemented.

- Erosion control devices will be used to minimize erosion where necessary, including to prevent transport of sediment to the marine environment via freshwater systems.
- Cleared slopes and embankments will be re-vegetated which will lead to long term slope stabilization.
- The Project will consider the use of native, shade-providing vegetation at regular intervals along the banks of watercourses that were confirmed to support salmonid species.
- Regular monitoring of runoff diversion and sediment control structures will be conducted to confirm that these structures operate properly and reduce the potential for sedimentation of watercourses. Monitoring and controlling of sedimentation will help minimize effects on surface water quality.
- Soil loss from slopes may occur even with erosion and runoff control measures. To prevent this soil from entering watercourses, further mitigative measures, including vegetated buffer strips, silt fences, filter berms and sediment traps will be implemented to intercept sediments as required.

Based on experience with erosion and sediment control measures in eastern Canada, it is recommended that these measures be designed to function to the applicable water quality limits during a 1-in-2 year return period storm event and designed to withstand a 1 in 10 year return period event without incurring significant damage.

The operation and maintenance of the coal and waste rock disposal piles have the potential to cause acidification of watercourses located in the same drainage basin, through either ground-based seepage or surface run-off. These effects will be mitigated through the development of a water collection and treatment system for each disposal pile that includes, but is not limited to, the following design characteristics:

- The coal and waste rock disposal piles will be engineered to include an impermeable liner that prevents seepage from the pile.
- Surface run-off from the disposal piles will be captured, contained, and treated prior to discharge.
- Specific preventative measures to mitigate the potential environmental effects from site runoff wastewater are further discussed in the Water Resources VEC (Section 5.2).

Water collected from mine dewatering operations will be fed through the existing passive treatment system and will continue to adhere to the current standards for water quality.

The potential for further environmental effects on fish habitat (including surface water quality) resulting from direct disturbance will be minimized by situating the temporary and permanent ancillary elements of the Phase III disposal pile at least 30 m from watercourses.

Operations at the Phase III coal and waste rock disposal pile are not anticipated to begin until approximately thirteen years from the initiation of Project activities. Prior to Project construction within the Schooner Pond LAA, an in-field watercourse determination and fish habitat survey will be conducted. The Schooner Pond LAA, will be assessed by aquatic specialists prior to the start of the Phase III disposal pile activities to verify the number of watercourses present within the LAA and to characterize the presence or absence of fish habitat within those watercourses. These designations (*i.e.,* watercourse and fish habitat) will be made using the applicable regulations and definitions in place at that time. Any additional regulatory protection applicable to freshwater resources will be taken into consideration at that time as well.

5.6.4.1.3 Characterization of Residual Project Environmental Effects

The operation of the coal waste disposal piles will require an engineered storage system of substantial size. Construction of the facility will require site grading, (*e.g.*, clearing and grubbing) during the operation and maintenance phase of the Project. These activities have the potential to release sediment to receiving watercourses within the Schooner Pond LAA. Sediment may also be released during the in-filling and diversion of streams infringed upon by the proposed engineered disposal piles. Sedimentation can result in several adverse effects on fish habitat. The development and implementation of a site-specific sediment and erosion control plan(included in the Project EMP), using the mitigation measures described above, is an effective means of minimizing residual adverse environment effects on fish habitat.

To prevent the infilling of Stream 2 during construction of the coal waste Phase III disposal pile, the stream will undergo a substantial diversion which will also allow the stream to maintain its hydrologic connection with Schooner Pond. Stream B is not anticipated to be diverted and as such will be in-filled during the construction of the Phase III disposal pile. Both of these activities represent direct alterations to a watercourse and will require a (Division 1) Water Approval by NSE under the Nova Scotia *Environment Act* and the Activities Designation Regulations prior to alteration of any watercourses. The watercourse alteration plans will also be forwarded to DFO for review under Section 20 of the *Fisheries Act*. DFO officials will determine if an authorization under Section 35(2) of the *Fisheries Act* (*i.e.*, a HADD) is required.

It is anticipated that the alteration of Stream 2 and the destruction of a portion of Stream B (via in-filling) will require a HADD Authorization from DFO. The Project will work with DFO to minimize the effects and footprint size of the Phase III coal waste disposal site while still meeting operation requirements. Off-site fish habitat compensation may be required to meet DFO's no-net-loss of productive capacity to fish habitat. The Project will work with DFO to determine habitat compensation requirements based on the final design of the Phase III disposal site. A conceptual habitat compensation plan is included in Appendix G. A more precise estimate of potential freshwater habitat loss at the Phase III disposal site will be conducted based on detailed design of the disposal facility and detailed watercourse surveys within its footprint.

Sedimentation effects during the alteration and in-filling of watercourses in the Schooner Pond LAA will be minimized through the application of comprehensive sediment and erosion control measures, as detailed above. All watercourse alterations will be carried out in compliance with the conditions set in the site-specific Water Approval and HADD authorization, and will also follow mitigation outlined in the Project EMP. The Project will oversee the alteration activities and will carry them out in accordance to the planning process. The Project, in collaboration with DFO, will design the Stream 2 diversion to avoid obstruction of fish passage to Schooner Pond, facilitate peak flows, and maintain natural stream conditions (*e.g.*, width, substrate type, depth, and riparian vegetation).

Without appropriate mitigation, fish habitat has the potential to undergo acidification from the Phase III disposal pile. Seepage from this disposal pile will be mitigated through the use of an impermeable liner that collects water and feeds it into a treatment system. Similarly, surface run-off will be captured, contained and fed into the same treatment system.

The current dewatering of the mining tunnels uses a passive water treatment system. A serpentine pond canal system facilitates the settling of fines, as the first step. From the serpentine pond, the wastewater flows over a weir and into the DEVCO settling pond. This passive system will be maintained and will continue to treat mine waters. A new, active system will be developed to treat the site runoff wastewater, including from the coal waste disposal piles. The new active system will prevent untreated wastewater from entering naturally occurring freshwater watercourses in the Schooner Pond and Donkin Peninsula LAAs.

The detailed design process had not been initiated at the time of writing; however, it is anticipated that the active water treatment system will be designed to specifically address the acidic nature of coal waste disposal pile waters. The projected treatment system will continue to use the existing serpentine pond canals for mine water treatment, but will use a chemical feed system to help neutralize the acidic disposal pile water. A water quality monitoring program will be developed for the site to confirm that water treatment operations do not result in adverse residual environmental effects on fish habitat.

The capture, containment, and treatment of coal waste disposal pile waters and mine waters will prevent adverse acidification effects on fish habitat. Using sediment and erosion control planning and mitigation, residual sedimentation effects on the Schooner Pond LAA fish habitat will be low and likely to occur only during the initial development of the engineered Phase III disposal site. The in-filling and diversion of Stream B and Stream 2, respectively, will result in a permanent effect on the original fish habitat within the Schooner Pond LAA. The loss of fish habitat will require compensation under Section 35(2) of the *Fisheries Act*. In collaboration with DFO, a compensation plan will be developed that results in the reclamation or creation of fish habitat of similar productivity as the habitat lost through Project activities.

5.6.4.2 Assessment of Change in Mortality Risk

5.6.4.2.1 Potential Environmental Effects

Within the operation and maintenance phase of the Project, two activities have the potential to affect a change in freshwater fish mortality risk: the disposal of coal waste on the Donkin Peninsula; and water treatment (including mine water and surface run-off from the site and the coal waste disposal piles). Specifically, the Phase III coal and waste rock disposal pile is planned to impinge upon two streams (Stream 2 and Stream B; see Figure 5.6.1a). The diversion and in-filling of these streams will result in direct effects on the mortality risk of fish inhabiting the streams within the area planned for alteration. The increase in mortality risk occurs through the potential for smothering of fish eggs, larvae, fry, juveniles or adults during in-filling or diversion of the streams. Adult fish may also have a higher mortality risk from the impact injuries.

Additional risk for increased fish mortality results from potential changes in hydrology related to watercourse alterations. For example, the diversion of a stream without appropriate mitigation (*i.e.*, fish salvage) can result in the dewatering of portions of stream inhabited by fish. In the absence of appropriate mitigation, freshwater fish are unlikely to survive the temporary de-watering of their habitat and will experience mortality from permanent stream de-watering.

The potential for coal waste dust to be liberated from the Phase III disposal pile may interact directly with fish inhabiting the Schooner Pond LAA as well. There may be lag time between the start of operation of the Phase III disposal pile and the revegetation of the disposal pile through the progressive reclamation plan. Within this window, coal and waste rock dust liberated from the disposal pile has the potential to make its way to the freshwater environment and settle on the substrate. Without appropriate mitigation, a sufficient quantity of settled dust could smother fish eggs and larvae residing in the stream substrate, resulting in an increased risk of freshwater fish mortality.

Untreated runoff from coal waste piles has the potential to cause acidification of freshwater systems in the absence of mitigation. Therefore, the Schooner Pond LAA watercourses are at risk of short-term and long-term acidification, which can result in an increased mortality risk for freshwater fish eggs and larvae that cannot tolerate low pH conditions.

5.6.4.2.2 Mitigation of Project Environmental Effects

The following mitigation measures will be used to protect freshwater fish from increased risk of mortality:

- Watercourse alterations will be completed in the dry.
    - Dam and pump procedures or channel diversion will be used and will follow the guidelines in the NSE Erosion and Sedimentation Control Handbook (NSE 1988) and Watercourse Alteration Specifications (NSE 1997 and updates).
    - Water pump intakes on the pumps will be screened in compliance with the DFO *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995).
- Fish salvage: isolation of fish from direct exposure to in-filling and diversion activities through the removal of fish from the stream area to be altered (*i.e.*, from within the dam and pump area).
- Avoidance of spawning periods for sensitive freshwater fish groups (*i.e.*, salmonids).
    - In-water work will be carried out between June 1st and September 30th.
    - In the event of late season work (*e.g.*, after September 30 and with regulatory approval) stabilization of exposed soils within the work area will be completed as follows:
        - Within 5 days of disturbance within 30 m of a watercourse (using mulch or another approved late season stabilization material), or prior to any forecasted storm event and/or the onset of frozen ground conditions; or
        - Within 30 days of disturbance beyond 30 m of a watercourse, or prior to any forecasted storm event and/or the onset of frozen ground conditions, when possible.
- Coal waste disposal piles will employ dust-control measures (*e.g.*, spraying of water and use fine-meshed screens) to prevent the liberation and movement of dust into freshwater systems (refer to Section 5.1 Atmospheric Resources).
- Specific preventative measures to mitigate the potential environmental effects from erosion and sedimentation as discussed in Section 5.6.4.1.2.

- Specific preventative measures to mitigate the potential environmental effects from acidification of freshwater resources from site run-off, and coal waste pile run-off are detailed above, under Section 5.6.4.1.2.

5.6.4.2.3 Characterization of Residual Project Environmental Effects

Through the application of mitigation, as outlined in the previous section, residual environmental effects on freshwater fish in the Schooner Pond LAA can be minimized. The development of an engineered, land-based coal waste disposal site will result in permanent alterations of Stream B and Stream 2, which will increase fish mortality risk if unmitigated. The final designs for the alteration of Stream B and Stream 2 will be forwarded for review to DFO under Section 20 of the *Fisheries Act*. DFO officials will also determine if an authorization under Subsection 35(2) and Section 32 of the *Fisheries Act* is required. It is anticipated that a HADD will be determined and that fish habitat compensation under DFO's *No Net Loss Policy* will be required (refer to Appendix G for a conceptual habitat compensation plan. Through continued collaboration with DFO, site-specific watercourse alteration mitigation will be finalized. The following discussion focuses on the methods which will be employed by the Project to minimize to the greatest extent practical, the adverse environmental effects on fish mortality.

In-water work will be conducted to avoid sensitive biological periods such as brook trout spawning and egg incubation times. In general, in-water work will be conducted between June 1 and September 30, where practical, to prevent the smothering of eggs, larvae and juvenile fish. During the summer, low water flow makes instream work easier and erosion more manageable. Where practical, watercourse alterations resulting from the coal waste disposal site development will be done in the dry, using dam and pump procedures or channel diversion and following the guidelines of the NSE Erosion and Sedimentation Control Handbook (NSE 1988) and Watercourse Alteration Specifications (NSE 1997 and updates). In either case, fish will be removed from the area of disposal site development activities prior to the start of the watercourse alteration using DFO approved methods (*e.g.*, seine nets or electrofishing). To further minimize fish mortality risk during the implementation of dam and pump mitigation, water pump intakes on the pumps will be screened in compliance with the DFO *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995).

Subject to regulatory approval, in-water watercourse alteration work may be conducted outside of the June 1 to September 30 period when seasonal weather conditions permit (where there is no anticipated environmental effect on sensitive life stages), when work must be completed prior to the onset of winter conditions, or where the advantages of completing the work (*e.g.*, sediment control structures) prior to winter conditions justifies late season work. In the event of in-water work outside of the June 1 to September 30 season DFO will be consulted and appropriate authorizations will be obtained. Any in-water work completed after September 30 will require monitoring during the work period, and inspection of sediment control mitigation during periods of the visible overland flow of water (*e.g.,* heavy rain or thaw events). Watercourse alterations will be conducted according to the conditions of the Water Approval to minimize potential for introduction to surface waters of contaminants or suspended sediments at levels that exceed the CCME Guidelines (25 mg/L) as described in Section 5.6.5.1.2 above.

The potential for residual environmental effects to fish through direct disturbance at a site during the operation and maintenance of the Phase III coal and waste rock disposal site will be minimized by limiting the area accessed, situating work and laydown areas at least 30 m from the watercourse, and remediating altered littoral zone areas to encourage re-population of biological organisms. An additional adverse effect of the Phase III coal waste disposal site operation is the potential deposition of coal and waste rock dust liberated from the disposal pile onto the surface water. Depending on the physical nature of the coal and rock dust, it may eventually settle to the bottom of the Schooner Pond LAA watercourses, smothering interstitial spaces and resulting in indirect effects on fish mortality risk through potential changes in dissolved oxygen at the substrate-water interface. Further, the smothering effect of the settled dust could be sufficient enough to directly affect fish eggs and larvae residing in the substrate, increasing fish mortality risk in the freshwater environment. These adverse environmental effects can be mitigated through dust suppression activities at the Phase III disposal pile and within the Schooner Pond LAA. A monitoring program focused on water quality and substrate quality (*e.g.*, through benthic invertebrate community sampling) will be used to confirm that the mitigation measures are working to protect fish from an increased mortality risk resulting from dust deposition.

A water quality monitoring program will also likely be required through the permitting process to confirm the effectiveness of mitigation measures employed to protect fish from acidification effects potentially resulting from the land-based disposal of coal waste.

Through comprehensive sediment and erosion control, the completion of watercourse alterations in the dry, the completion of fish salvage in areas to be altered prior to the start of alteration activities, the control of dust dispersion from the Phase III disposal pile (including progressive reclamation), and the implementation of an acid-neutralizing water treatment system, residual adverse environmental effects on freshwater fish mortality will be negligible.

5.6.4.3 Summary of Project Residual Environmental Effects

Table 5.6.9 summarizes the residual environmental effects of the Project on freshwater fish and fish habitat.

Table 5.6.9 Summary of Project Residual Environmental Effects: Freshwater Fish and Fish Habitat

Project Phase	Mitigation/ Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		
Change in Fish Habitat										
Operation and Maintenance (Water treatment (including mine water and surface runoff))	• Avoidance of Streams 1 and A. • No unnecessary unauthorized activities within 30 m buffer around watercourses. • Sediment and erosion control planning.	A	L	S	LT	C	R	U	N	Schooner Pond LAA Watercourses: • Benthic invertebrate monitoring program (quantitative including enumeration and identification of benthic macroinvertebrates). • Fish habitat monitoring program (including *in situ* water quality and detailed physical habitat assessment). • Water quality monitoring program (including TSS).
Operation and Maintenance (Coal waste disposal: stream in-filling and diversion)		A	L	S	P	C	I	U	N	
Operation and Maintenance (Coal waste rock disposal: all activities other than stream in-filling and diversion)		A	L	S	LT	O	R	U	N	

Table 5.6.9 Summary of Project Residual Environmental Effects: Freshwater Fish and Fish Habitat

Project Phase	Mitigation/ Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		
	• Impermeable liner under waste rock disposal piles. • Water treatment system to capture and contain site and disposal pile runoff; system will avoid direct interaction with all natural watercourses. • Water treatment system will neutralize acid waters from operations. • HADD compensation.									HADD Compensation: • Fish habitat monitoring program testing productivity within the HADD compensation project area against reference site(s).
Change in Fish Mortality Risk										
Operation and Maintenance (Water treatment (including mine water and surface runoff))	• Watercourse alterations will be completed in the dry. • Fish salvage will be completed within	A	L	S	LT	C	R	U	N	Schooner Pond LAA Watercourses: • Fish community survey (qualitative, non-destructive; including *in situ* water quality).
Operation and Maintenance (Coal and waste rock disposal: stream in-filling and diversion)		A	L	S	ST	O	R	U	N	

Table 5.6.9 Summary of Project Residual Environmental Effects: Freshwater Fish and Fish Habitat

Project Phase	Mitigation/ Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		
Operation and Maintenance (Coal and waste rock disposal: all activities other than stream in-filling and diversion)	alteration areas. • Watercourse alterations will avoid spawning periods of sensitive freshwater fish groups (*i.e.*, salmonids) unless authorized. Water treatment system will neutralize acid waters from operations. • Sediment and erosion control plan will be implemented. • Dust-control measures will prevent liberation of waste rock disposal pile dust.	A	L	S	LT	C	R	U	N	HADD Compensation: • Fish community study (quantitative, non-destructive; including *in situ* water quality and reference site fish surveys)

Table 5.6.9 Summary of Project Residual Environmental Effects: Freshwater Fish and Fish Habitat

Project Phase	Mitigation/ Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		

KEY

Direction:

P Positive: condition is improving compared to baseline habitat quality or population status

A Adverse: negative change compared to baseline habitat quality or population status

N Neutral: no change compared to baseline habitat quality or population status

Magnitude:

L Low: measurable effects to habitat function anticipated in low-sensitivity habitats and no measurable reduction in number of any fish species anticipated

M Moderate: measurable effects to habitat function anticipated in moderately sensitive habitats or anticipated mortality risk to non-listed species

H High: measurable effects to habitat function anticipated in highly sensitive habitat or habitat designated as important for listed species or anticipated mortality risk to listed species

N Negligible: no measurable adverse effects anticipated

Geographic Extent:

S Site: effects restricted to habitat within the PDA

L Local: effects extend beyond Project footprint but remain within the LAA

R Regional: effects extend into the RAA

Duration:

ST Short term: effects are measurable for days to a few months

MT Medium term: effects are measurable for many months to two years

LT Long term: effects are measurable for multiple years but are not permanent

P Permanent: effects are permanent

Frequency:

O Once: effect occurs once

S Sporadic: effect occurs more than once at irregular intervals

R Regular: effect occur on a regular basis and at regular intervals

C Continuous: effect occurs continuously

Reversibility:

R Reversible: effect will cease during or after the Project is complete

I Irreversible: effect will persist after the life of the Project, even after habitat restoration and compensation works

Environmental Context:

U Undisturbed: effect takes place in an area that has not been adversely affected by human development

D Disturbed: effect takes place in an area that has been previously adversely affected by human development or in an area where human development is still present

N/A Not Applicable

Significance:

S Significant

N Not Significant

5.6.5 Assessment of Cumulative Environmental Effects

In association with the Project environmental effects discussed above, an assessment of the potential cumulative environmental effects was conducted for other projects and activities that have potential to interact with the Project (refer to Section 4.2.4 for a description of the projects and activities). Table 5.6.10 presents the potential cumulative environmental effects to Freshwater Fish and Fish Habitat, and ranks each interaction with other projects as 1 or 2 with respect to the nature and degree to which important Project-related environmental effects overlap with those of other projects and activities. Projects and activities which are considered to have no cumulative interactions (*i.e.,* 0 ranking are not discussed).

Table 5.6.10 Potential Cumulative Environmental Effects to Freshwater Fish and Fish Habitat

Other Projects and Activities with Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects	
	Change in Freshwater Fish Habitat	Change in Mortality Risk
Historic Coal Mining Operations	2	2
Donkin Coal Exploration Project	1	1
Recreational Angling	1	1
Maritime Link (Transmission Line)	1	1

KEY

0 = Project environmental effects do not act cumulatively with those of other projects and activities.
1 = Project environmental effects act cumulatively with those of other projects and activities, but the resulting cumulative effects are unlikely to exceed acceptable levels with the application of best management or codified practices.
2 = Project environmental effects act cumulatively with those of other projects and activities and the resulting cumulative effects may exceed acceptable levels without implementation of project-specific or regional mitigation.

Coal mining in Cape Breton has occurred since the early 1700s, with the first coal mine opened in Port Morien in 1720 (Cape Breton Miner’s Museum 2012).These coal mines were predominantly surficial until the early 1800s when the technology for subterranean mines became more readily available. The construction and operation of these mines produced a change in associated freshwater habitats through the physical and chemical alteration of watercourses (Pioneer Coal 2004, Pioneer Coal 2005). Physical alteration of watercourses in Cape Breton may have occurred through the infilling and diversion of freshwater resources. Specifically, mine sites in the RAA, such as Dominion Mines 24, 4 and 8 (Figure 4.2.1), may have affected freshwater habitats within the area of the transmission line route through physical alterations to habitat such as infilling, or through chemical alteration of habitats.

The chemical alteration of fish habitat may occur through surface water runoff from waste rock piles and sedimentation from erosion. These chemical interactions reduce the quality of fish habitat. The physical and chemical effects on a change in fish habitat from historical coal mine development are not confined to the RAA but are limited in range to the northern coast of the Island of Cape Breton, where mining activity has been focused historically. It is anticipated that the historical infilling of watercourses and alteration of the chemical attributes of freshwater fish habitat resulted in a change in the mortality of freshwater fish species as well. Species of special status or intrinsic value, such as Atlantic salmon or brook trout, may have also been affected. The adverse cumulative environmental effects on freshwater fish and fish habitat resulting from historical coal mine operations are considered long lasting, although past and ongoing mine remediation projects have likely reduced some of the environmental effects associated with these abandoned sites.

The Donkin Mine Exploration Project interacted with Freshwater Fish and Fish Habitat through the following (CBCL 2008):

- The preparation of the surface for buildings and equipment
- The construction of the access road
- The treatment of water from mine dewatering and surface runoff

Mitigation to reduce or eliminate the effects to freshwater fish and fish habitat on the Donkin Peninsula during these activities were subjected to an Industrial Approval from NSE and included:

- A Watercourse Alteration Application submitted to NSE and approved for the installation of culverts along the mine access road;
- Culvert installation as per the NSE Watercourse Alteration Specification for Pipe Culverts and erosion and sedimentation control;
- Design and implementation of a passive water treatment facility to treat surface and mine water; and
- The routine monitoring of the passive water treatment facility to confirm that effluent was of a quality to support freshwater aquatic life.

Ongoing water quality and fish toxicity monitoring have confirmed no adverse environmental effects have occurred during the care and maintenance phase of the Exploration Project. Therefore, the elements of Donkin Underground Exploration Project that were implemented would not contribute to substantial cumulative adverse environmental effects on freshwater fish and fish habitat.

Recreational angling for freshwater species occurs within the RAA, which is known to have an effect on freshwater fish through a change in mortality risk. Angling in the freshwater environment is primarily focused on the catch of Atlantic salmon and brook trout. Atlantic salmon habitat was identified within a study on Significant Habitats: Atlantic Coast Initiative (SHACI) Unit 11 (Schaefer *et al*. 2004) and included two watercourses within the RAA. Big Glace Bay Lake was determined to be an estuarine staging area prior to the upstream migration for Atlantic salmon. Southwest River was also identified in the report as Atlantic salmon habitat. Neither of these locations supports a population stable enough to allow a retention fishery for Atlantic salmon; therefore, preservation of the Atlantic salmon within these waters is a priority. Observations made during the Stantec habitat assessment indicated that angling for brook trout may occur within the larger watercourses such as Stream 10 (Renwick Brook) and Stream 18 (Southwest Brook). Locally, Donkin Dam Pond (the Former Donkin Reservoir) has been identified as an area frequented by anglers in the search of brook trout, but this pond falls outside of the PDA. Mitigation for recreational fisheries include limited licensing, regulated seasons, size limits, and quota limits. The seasons, size and quota limits for recreational fish are determined through scientific publications and studies, and represent to the best available knowledge of the amount of biomass that can be sustainably removed from the environment. Cumulative effects from recreational fishing are anticipated to extend beyond the RAA, occurring on a regular basis, and into the foreseeable future. Through the mitigation listed above, these effects should be managed to acceptable levels to maintain fish populations.

The proposed Maritime Link Project includes a submarine transmission cable from Newfoundland to Cape Breton to supply power generated from the Lower Churchill Hydroelectric Project to Nova Scotia. The project includes the laying of the marine cable and the construction of nearshore and land-based structures, including a transmission line from the marine environment to the Woodbine converter station. Impacts to freshwater fish and fish habitat are limited to the area required for the development of the transmission line corridor along an existing 50 km section of transmission line. No new clearing is planned for the active portion of the transmission line corridor; however new poles and lines will be required within the active portion of the corridor to facilitate the increased power transmission. NSPI follows internal protocols designed to protect freshwater resources crossed by their transmission lines, including during clearing activities and regular maintenance (see Section 5.6.3). As a result of the freshwater protective measures put in place by NSPI, the Maritime Link Project is anticipated to have no cumulative environmental effect on freshwater fish and fish habitat located within the RAA.

5.6.6 Determination of Significance

Several Project activities interact with the Freshwater Fish and Fish Habitat VEC resulting in effects that can be managed to acceptable levels through best management practices and industry standard mitigation. These include the construction phase activities of site preparation, construction of mine site infrastructure, and construction of the transmission line. The development and implementation of a sediment and erosion control plan will serve to mitigate the primary environmental effect resulting from the interaction of these activities with freshwater fish and fish habitat: the potential for sedimentation of the natural watercourses on the Donkin Peninsula. During operation and maintenance, potential interactions between coal handling and preparation activities and the freshwater environment will be effectively mitigated through the use of closed conveyance systems, isolated from freshwater resources. Site decommissioning and reclamation activities can also be effectively managed to prevent adverse environmental effects on Freshwater Fish and Fish Habitat through progressive reclamation and ongoing surface water treatment systems. Given the implementation of best available management practices and mitigation, none of these project activities will result in significant adverse residual environment effects on Freshwater Fish or Fish Habitat.

Two operation and maintenance phase activities have greater potential for residual environmental effects on freshwater fish and fish habitat on the Donkin Peninsula: land-based coal waste disposal in the Schooner Pond LAA; and water treatment (*i.e.,* water run-off from the site and from the coal waste disposal pile). Many types of direct and indirect interactions are possible between these two operation and maintenance phase Project activities and the Freshwater Fish and Fish Habitat VEC including sedimentation, coal waste deposition, and acidification. These effects can result in changes to fish habitat through changes in water quality and substrate composition, as well as increase the potential mortality risk for fish inhabiting the Schooner Pond LAA. However, the site-specific mitigation measures that will be developed and implemented, in addition to the sediment and erosion control plan and EMP, will reduce severity and frequency of these potential residual effects.

Coal waste disposal in the Schooner Pond LAA will result in the permanent alteration of fish habitat through the diversion of Stream 2 and the in-filling of Stream B. The adverse environmental effects of this change in fish habitat will be mitigated through DFO-approved HADD compensation planning and implementation. HADD compensation is designed to result in a no-net loss of productive fish habitat. Permanent alteration of freshwater fish habitat is likely also to have occurred in the cumulative residual effects of historical mining activities within the RAA. During early mining activities in the RAA, freshwater resources did not fall under regulatory protection. In the absence of the requirement for HADD compensation, the historical mining activity is anticipated to have resulted in a loss of productive fish habitat in the RAA. The process of HADD authorization and compensation planning that will be undertaken for the current Project will prevent the activities of the current Project from contributing further to the historical cumulative effect of the loss of productive fish habitat within the RAA.

In summary, Project-related and cumulative adverse residual environmental effects during all Project phases are predicted to be not significant for Freshwater Fish and Fish Habitat.

5.6.7 Follow-up and Monitoring

The follow-up and monitoring programs listed in Table 5.6.9 will be implemented for the Freshwater Fish and Fish Habitat VEC.

The following monitoring programs will be implemented in accordance with applicable permitting, regulations and scientific methods and in consultation with local regulators, notably DFO.

- Benthic Invertebrate Monitoring Program - to monitor the biological activity within the sediments of the PDA during the initial stages of operation and maintenance.
- Freshwater Fish Habitat Monitoring Program and Fish Community Study - to monitor the biological activity surrounding the HADD compensation project for Stream 2 and Stream B, to ensure viability and productivity of artificial habitats.
- Freshwater Fish Habitat Follow-up Program within the mine site - to assess the interaction of the project with altered watercourses.
- Water quality monitoring, including TSS – to monitor effectiveness of sedimentation and erosion control mitigation within the natural watercourses of the PDA during pre-construction, construction, operation and maintenance, and decommissioning and reclamation phases.

5.7 MARINE ENVIRONMENT

The Marine Environment has been selected as a VEC based on interactions of the Project with marine fish and marine fish habitat, regulatory protection of fish and fish habitat, and the intrinsic connection to the local commercial fisheries and local communities. The Marine Environment VEC focuses on resident and migratory marine fish and fish habitat likely found within the waters surrounding the Donkin Peninsula. Special consideration is given to marine species at risk, habitats of high productivity/ecological sensitivity, and candidate marine protection areas.

The assessment of potential environmental effects on marine fish and fish habitat focuses on key Project components that interact with the Marine Environment including: the construction of the barge load-out wharf and breakwater structure and associated moorings (the barge load-out facility) and the installation of moorings at the transshipment locations; the operation of the marine-based coal loading and unloading process at the wharf as well as at the transshipment location; and the marine route for the barges between the barge load-out facility and the transshipment location.

The Marine Environment VEC is closely related to the Commercial and Recreational Fisheries VEC (Section 5.8) and the Current Use of Land and Resources for Traditional Purposes by the Mi’kmaq of Nova Scotia VEC (Section 5.10).

5.7.1 Scope of Assessment

This section defines the scope of the environmental assessment for the Marine Environment in consideration of the nature of the regulatory setting, issues identified in public engagement, potential project–VEC interactions, and existing knowledge.

5.7.1.1 Regulatory Setting

Marine fish, fish habitat, water quality and sediment quality are protected under federal and to some extent provincial legislation. Fish are protected under the federal *Fisheries Act* specifically by Section 32, which prohibits the destruction of fish by any means other than fishing. Fish habitat is protected under the *Fisheries Act* and by DFO *Policy for the Management of Fish Habitat* (DFO 1986). The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The *Policy for the Management of Fish Habitat* is regulated by Sections 20, 21, 22, 30, 35, 36, 37, 40 and 43 of the *Fisheries Act* and applies to any project which occurs in or near water. Specifically, Sections 20, 32, 35 and 36 of the *Fisheries Act* apply to the present Project. Section 20 requires that fish passage be maintained at all times during construction and operation and maintenance. Section 35 protects fish habitat from harmful alteration, disruption or destruction (HADD), and Section 36 prohibits the deposit of a deleterious substance in waters frequented by fish. DFO has overall responsibility for the administration of the federal *Fisheries Act*, except for Section 36 which Environment Canada has been delegated to act on behalf of the federal Minister of Fisheries and Oceans to uphold this pollution provision.

In the context of the Marine Environment VEC, the following definitions apply:

Fish is defined in Section 2 of the *Fisheries Act* and includes: (a) parts of fish, (b) shellfish, crustaceans, marine animals, and any parts of shellfish, or crustaceans, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

Fish habitat as defined in Section 34(1) of the *Fisheries Act* includes spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. Fish habitat will be assumed to include the physical (*e.g.*, substrate/sediment, temperature, and current velocities), chemical (*e.g.*, water quality), and biological (*e.g.*, fish, benthic macroinvertebrates, algae, plankton) attributes of the Marine Environment that are required by fish to carry out life cycle processes.

Marine Environment includes marine fish and their habitat located within the vicinity of the Project, with spatial boundaries defined in Section 5.7.1.4. Species of marine fish which are extirpated, endangered or threatened are protected under the federal *Species at Risk Act* (SARA) which generally limits exposure of listed endangered species or critical habitats for listed species to be interfered with, disturbed, or destroyed. General prohibitions include Section 32(1), which states that no person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species as listed in Schedule 1 of SARA and Section 59 critical habitat regulations. No approvals under SARA are likely required for marine species with respect to the Project.

Species of Conservation Concern (SOCC) are species that are not formally protected under SARA but that have been identified by other agencies (*e.g.,* Committee on the Status of Endangered Wildlife in Canada, COSEWIC) as being sensitive and/or rare. In this section, species at risk and SOCC are together referred to as species of conservation interest.

5.7.1.2 Influence of Consultation and Engagement on the Assessment

During the stakeholder and public engagement process, the main issues raised by stakeholders and community members related to the Marine Environment were water quality, loss of habitat and dust impacts on the marine environment. Issues related to Commercial and Recreational Fisheries are addressed in Section 5.8.

5.7.1.3 Selection of Environmental Effects and Measurable Parameters

The environmental assessment of the Marine Environment is focussed on two broad environmental effects:

- Change in Marine Fish Habitat; and
- Change in Mortality Risk

A Change in Marine Fish Habitat may occur through direct alteration, disruption or destruction of the seafloor during the construction of the barge load-out facility. Anchors and chains utilized to stabilize the barge swing circle mooring and the transshipment mooring will also change the marine fish habitat. Increased sound levels (magnitude, frequency and duration) above background levels from construction, mainly infilling for the breakwater structure, may affect the marine environment surrounding the barge load-out facility and transshipment mooring. Marine mammals are especially vulnerable to increases in sound levels which affect communication and navigation.

During Project operation, the loss of coal into the marine environment may occur during the transfer from conveyor to barge or from barge to bulk carrier. Spilled coal will eventually settle to the seafloor and may alter the physical and chemical make-up of the marine benthic habitat. The alteration of the marine habitats will include areas within footprint of the marine structures and adjacent areas. Increased ambient marine sound levels may occur from increased vessel traffic within the Local Assessment Area (LAA) and the Regional Assessment Area (RAA) defined below and may affect habitat for marine mammals. The effluent from the mine water treatment process and site drainage will eventually be released into the marine environment at Schooner Pond Cove from DEVCO Pond via a culvert. This treated effluent is largely fresh water and may have a local effect on the water quality of the Marine Environment.

A Change in Mortality Risk may occur during the construction of the barge load-out facility. Non-mobile marine species or species with low mobility may not be able to avoid the placement of materials used for the creation of the breakwater, or the caissons or timber cribwork used to construct the barge load-out wharf. The anchors used to stabilize the barge swing circle and transshipment mooring may also increase the risk of mortality to benthic organisms during the initial placement. There may be an ongoing sweep of anchor chains used to stabilize the barge and transshipment moorings. This sweep of chains may have a destabilizing effect on the benthic habitat in the immediate area of the swing circle. However, the sweeps from chains will be minimal due to the four-point anchor design of the single buoy moorings, thereby limiting the movement of chains in any one direction and therefore the sweeps on the benthic habitat.

The two categories of environmental effects on the Marine Environment and the associated measurable parameters used for the assessment of the environmental effects presented above and the rationale for their selection is provided in Table 5.7.1.

Table 5.7.1 Measurable Parameters for the Marine Environment

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Marine Habitat	• Water quality using CCME Water Quality Guidelines for the Protection of Marine Aquatic Life • Sediment quality using CCME Marine Sediment Quality Guidelines • Change in benthic habitat HADD (m^2) • Underwater sound levels in dB re 1uPa	The *Fisheries Act* provides for the protection of fish habitat. The unauthorized harmful alteration, disruption or destruction of habitat and deposit of a deleterious substance into waters frequented by fish is prohibited under the *Fisheries Act*. Quantification of these actions is necessary to request authorization and calculate compensation requirements. Water and sediment quality sampling results can be measured against CCME aquatic guidelines and Interim Sediment Quality Guidelines and Probable Effects Level to assess environmental effects. Increase in sound levels (magnitude, frequency, duration and character – tonal *vs.* impulsive) above background levels as a result of construction or increased vessel traffic may affect the local marine ecosystem and result in increased presence/absence of marine biota (particularly marine mammals). The Marine Mammal Regulations under the *Fisheries Act* prohibits the disturbance of whales and other marine mammals.
Change in Mortality Risk	• Mortality (loss of individuals attributable to the Project as measured by number of individuals)	Section 32 of the *Fisheries Act* prohibits the unauthorized killing of fish by means other than fishing. Number of fish or marine mammals accidentally killed as a result of the Project would reflect on mortality risk.

5.7.1.4 Temporal and Spatial Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the Marine Environment include the periods of construction, operation and maintenance, and decommissioning and reclamation.

It is anticipated that the construction period of the marine works would occur over Q4 2014 to Q2 2016 (approximately 17 months). The operation and maintenance phase of the Project is predicted to result in 30 years of coal production.

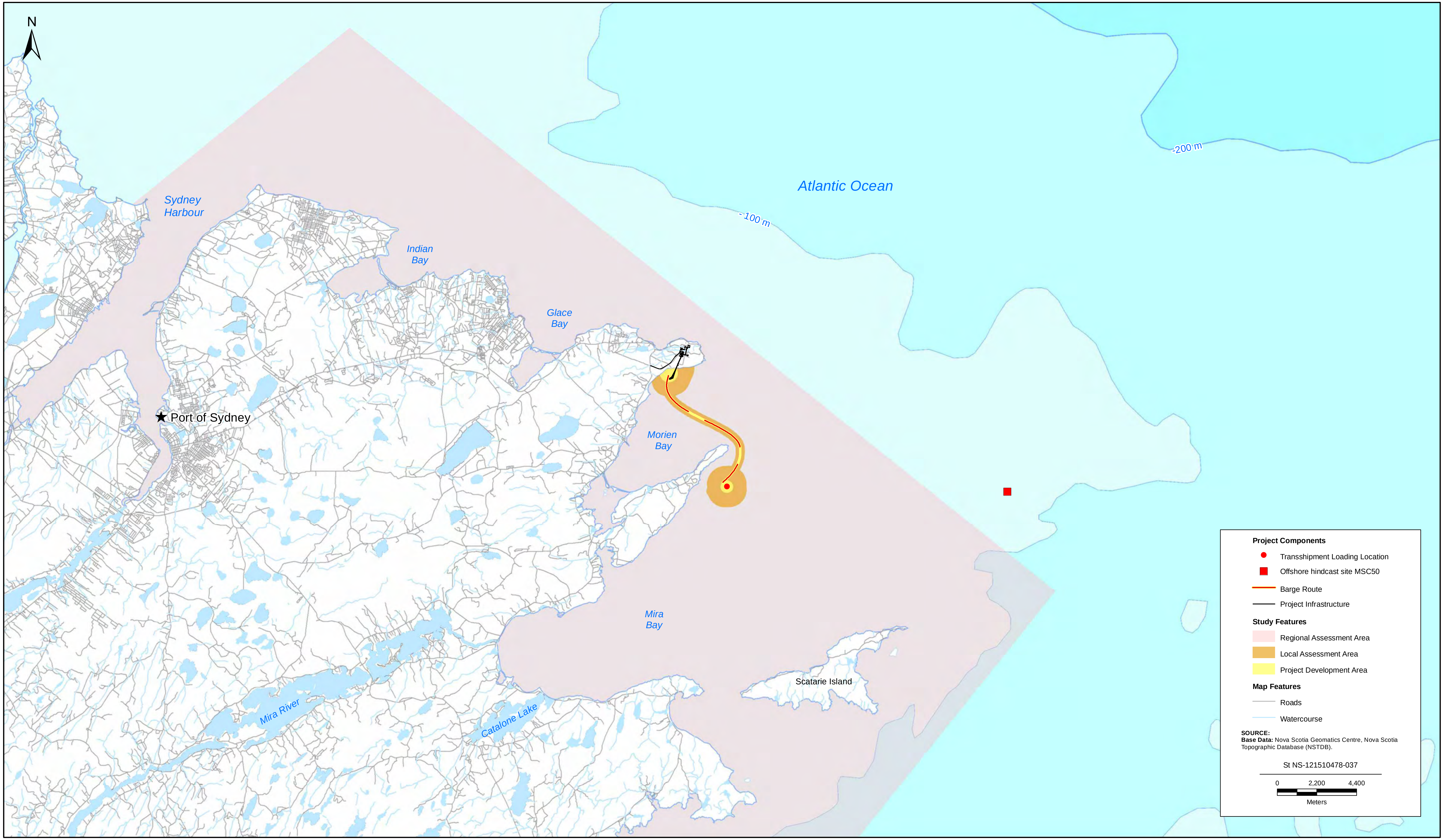
Temporal boundaries have also been developed in consideration of seasonally sensitive periods for marine species such as spawning and migration.

The spatial boundaries for the environmental effects assessment of the Marine Environment VEC are defined below and illustrated in Figure 5.7.1.

Project Development Area (PDA): The PDA includes the area of physical disturbance for the Project and includes the barge load-out facility and transshipment mooring and vessel route between the two. The PDA is the area represented by the physical Project footprint as defined in the Project Description.

Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the PDA and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. For the Marine Environment VEC, the LAA is defined as the 1 km^2 area surrounding the barge load-out wharf and the barge swing circle; a 500-m wide corridor following the barge route between the barge load-out wharf and the transshipment location; and a 1 km^2 area surrounding the transshipment location. The LAA is based on the area of predicted changes in ocean currents from the construction of the breakwater, the proposed route of barge shipment and area of potential elevated marine noise levels from construction and operation.

Regional Assessment Area (RAA): The RAA is the area within which cumulative environmental effects for marine environment may occur, depending on physical and biological conditions and the type and location of other past, present, and reasonably foreseeable projects. The RAA includes the coastal region from Scatarie Island in the south to Sydney Harbour in the north. This area is bordered to the west by Cape Breton Island and to the east by the navigational lanes for shipping. The RAA includes Morien and Mira Bays and borders on the St. Anns Bank Area of Interest.



PREPARED BY: K Keizer	Donkin Export Coking Coal Project	FIGURE NO.: 5.7.1
REVIEWED BY: M Steeves		DATE: Jun 26, 2012
CLIENT: xstrata coal	**Marine Environment Assessment Areas**	Stantec

File Path: V:\1215\active\121510xxx\121510478-Donkin Mine Enviro Assessment\geomatics\mapping\mxd\EA_Final\ST_NS_121510478_037_Marine_Project_Overview_20120309.mxd

5.7.1.5 Residual Environmental Effects Description Criteria

Terms that will be used to characterize residual environmental effects for Marine Environment (summarised in Table 5.7.20) are presented in Table 5.7.2.

Table 5.7.2 Environmental Effects Characterization Terminology

Criterion	Description
Direction	**Positive:** condition is improving compared to baseline habitat quality or population status **Neutral:** no change compared to baseline habitat quality or population status **Adverse:** negative change compared to baseline habitat quality or population status
Magnitude	**Negligible:** no measurable adverse effects anticipated **Low:** measurable effects to habitat function anticipated in low-sensitivity habitats and no measurable reduction in number of any marine species anticipated **Moderate:** measurable effects to habitat function anticipated in moderately sensitive habitats or anticipated mortality risk to non-listed species **High:** measurable effects to habitat function anticipated in highly sensitive habitat or habitat designated as important for listed species or anticipated mortality risk to listed species
Geographical Extent	**Site-specific:** effects restricted to habitat within the PDA **Local:** effects extend beyond PDA but remain within the LAA **Regional:** effects extend into the RAA
Frequency	**Once:** effect occurs once **Sporadic:** effect occurs more than once at irregular intervals **Regular:** effect occurs on a regular basis and at regular intervals **Continuous:** effect occurs continuously
Duration	**Short-term:** effects are measurable for days to a few months **Medium-term:** effects are measurable for many months to two years **Long-term:** effects are measurable for multiple years but are not permanent **Permanent:** effects are permanent
Reversibility	**Reversible:** effects will cease during or after the Project is complete **Irreversible:** effects will persist after the life of the Project, even after habitat restoration and compensation works
Ecological Context	**Disturbed:** effect takes place in an area that has been previously adversely affected by human development or in an area where human development is still present **Undisturbed:** effect takes place in an area that has not been adversely affected by human development

5.7.1.6 Threshold for Determining the Significance of Residual Environmental Effects

A **significant residual adverse environmental effect** on the Marine Environment is one that results in any of the following.

- The unauthorized destruction of fish as described in the *Fisheries Act*, by the Project through any means other than fishing.
- An unmitigated or non-compensated net loss of fish habitat through physical, chemical, or biological means, such that natural recruitment would not re-establish the community to its original composition, density and extent in one generation.
- An adverse change (caused by avoidance and/or mortality) in the distribution or abundance of a fish species that is dependent upon that habitat, such that natural recruitment would not re-establish the species to its original composition, density and extent in one generation.

A **significant residual adverse environmental effect** on any species of conservation interest is one that results in any of the following.

- A non-permitted contravention of any of the prohibitions stated in Sections 32-36 of SARA (*i.e.,* it is an offence to kill, harm, capture, take, possess, collect and sell endangered or threatened species, as well it is illegal to damage or destroy the residence, for example the nest or den, of an endangered or threatened species).
- The alteration of marine habitat physically, chemically or biologically, in quality or extent, in such a way as to cause a decline in the distribution or abundance of a viable marine population of special status that is dependent on that habitat, such that the likelihood of the long-term survival of these populations within the RAA is substantially reduced as a result.

5.7.2 Existing Conditions

The existing conditions of the Marine Environment with the assessment areas are described in the following sections.

5.7.2.1 Regional Overview

The proposed Project is located off the east coast of Cape Breton on the Donkin Penisula. The peninsula is located within an area known as Sydney Bight which includes the east coast of Cape Breton Island from Scatarie Island to Cape North (Figure 5.7.1). This area generally consists of productive coastal waters boarded by the deep waters of the Laurentian Channel to the northwest. The majority of Sydney Bight is shallow water with depths less than 100 m with the exception of a deep 100 m – 200 m section on the northeast side. Sydney Bight contains important habitat for many species of marine species such as immature Atlantic cod, Atlantic herring, seals and crab species. In the summer Sydney Bight is influenced by fresher and warmer waters flowing in from the Gulf of St. Lawrence. During the winter and spring seasons, the area is exposed to sea ice moving out of the Gulf of St. Lawrence (Schaefer *et al.* 2004). A significant amount of commercial traffic flows through the area with a ferry service from North Sydney to Newfoundland and Labrador, as well as passenger cruise vessels and other ships transporting coal and freight through Sydney Harbour.

The benthic substrate in the area generally follows contour depth patterns. Areas that are less than 100 m generally consist of Sable Island sand and gravel leading to Sambro sand in depths greater than 100 m. Water temperatures and salinity tend to vary with the seasons and with depth. During the winter, the surface water temperatures are the coldest (0°C) and increase with depth. Between June and October the surface water temperatures usually warm up to approximately 15°C or higher, with the water column stratifying with a warm upper layer, cold middle layer, and an intermediate bottom layer. During the summer months surface salinities are at their lowest and range from 28-29 parts per thousand (‰) and 32-35 ‰ at the bottom. These surface salinities result from a freshwater pulse from rivers located in the Gulf of Lawrence. Surface salinities rise in the winter in the absence of this freshwater, with surface salinities of approximately 31.5 ‰ and bottom salinities of up to 34 ‰ (Schaefer *et al.* 2004).

The exposed rocky shoreline provides suitable habitat for subtidal flora, which in turn provides habitat for many species of fish and invertebrate species. The area is an important breeding, spawning, and overwintering area for many fish and invertebrate species. Common flora found in the area at shallow depths include kelp, rockweed and Irish moss. Lobster is the main commercial fishery in Sydney Bight, with snow crab, rock crab, groundfish, capelin, and herring also being fished commercially. Whales and sea turtles have also been known to forage in the area. Seal species also use the coastal islands in the area as breeding ground (Schaefer *et al.* 2004). Due to the high abundance of species and human interaction in the area, several species have been listed as at risk by SARA and COSEWIC. These species including marine fish, marine mammals and sea turtles are described in more detail in Section 5.7.2.2.

5.7.2.2 Species at Risk

A summary of all species anticipated to be found within the Regional Assessment Area (RAA) that are considered at risk under SARA and/or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) are presented in Tables 5.7.3 and 5.7.4, respectively. These tables also indicate the probability of their occurrence with the Project’s RAA based on typical habitat preferences.

Schedule 1 of SARA is the official list of wildlife species at risk. Where a species is both listed under Schedule 1 of SARA and designated as ‘at risk’ by COSEWIC, it is the SARA designation that legally applies. Individual species descriptions of those species listed under SARA or designated under COSEWIC are provided in the following series of sub-sections.

Table 5.7.3 Species at Risk in the Regional Assessment Area

Common Name	Species Name	SARA Schedule 1 Status	Probability of Occurrence within the RAA
Marine Fish			
White Shark (Atlantic population)	*Carcharodon carcharias*	Endangered	Low
Spotted Wolffish	*Anarhichas denticulatus*	Threatened	Low
Northern Wolffish	*Anarhichas denticulatus*	Threatened	Low
Atlantic (striped) Wolffish	*Anarhichas minor*	Special Concern	Low
Marine Mammals			
Blue Whale (Atlantic Population)	*Balaenoptera musculus*	Endangered	Low
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered	Low
Fin Whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Low
Sea Turtles			
Leatherback Sea Turtle	*Dermochelys coriancea*	Endangered	Low

Table 5.7.4 Species Designated 'At Risk' by the Committee of the Status of Endangered Wildlife in Canada in the Regional Assessment Area

Common Name	Species Name	COSEWIC Designation	Probability of Occurrence within the RAA
Marine Fish			
American Eel	*Anguilla rostrata*	Special Concern	Moderate
Atlantic Bluefin Tuna	*Thynnus thynnus*	Endangered	Moderate
Atlantic Cod (Laurentian South population)	*Gadus morhua*	Endangered	High
Atlantic Salmon (Eastern Cape Breton population)	*Salmo salar*	Endangered	Moderate
Basking Shark (Atlantic population)	*Cetorhinus maximus*	Special Concern	Low
Blue Shark (Atlantic population)	*Priomace glauca*	Special Concern	Low
Porbeagle Shark	*Lamna nasus*	Endangered	Low
Shortfin Mako (Atlantic Population)	*Isurus oxyrinchus*	Threatened	Low
Spiny Dogfish (Atlantic population)	*Squalus acanthias*	Special Concern	Low
Striped Bass (Southern Gulf of St. Lawrence population)	*Marone saxatilis*)	Threatened	Low
Winter Skate (Eastern Scotian Shelf population)	*Leucoraja ocellata*	Threatened	Low

Table 5.7.4 Species Designated 'At Risk' by the Committee of the Status of Endangered Wildlife in Canada in the Regional Assessment Area

Common Name	Species Name	COSEWIC Designation	Probability of Occurrence within the RAA
Marine Mammals			
Harbour Porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Special Concern	Low
Killer Whale	*Orcinus orca*	Special Concern	Low
Humpback Whale	Megaptera novaeangliae	Special Concern	Low
Sea Turtles			
Loggerhead Sea Turtle	*Caretta caretta*	Endangered	Low

5.7.2.2.1 Marine Fish

There are 14 species of marine fish that could potentially be found within or near the RAA that are considered at risk. The status of these species is presented in Tables 5.7.3 and 5.7.4.

American Eel

American eel are found from northern South America to Greenland and Iceland. They breed at sea and return to fresh water to feed and grow; all spawners are part of a single breeding unit. Spawning and hatching takes place in the Sargasso Sea and spawning occurs only once per adult. The larval stages are completely physiologically dissimilar to the adult eel. The life stages are: egg; leptocephalus (larval form); glass eel (upon reaching the Continental Shelf; unpigmented); elver (progressively pigmented as they approach shore), yellow eel (the growth stage of the life cycle); and silver eel (the spawning stage of the life cycle) (COSEWIC 2006a). Eel densities have been studied in the Margaree River in Cape Breton showing a trend of populations peaking in the early 1960's, slowly declining in the 1970's, and have since declined to very low levels to date (COSEWIC 2006a).

Atlantic Bluefin Tuna

The Atlantic bluefin tuna are a warm-blooded pelagic species that is distributed from the Gulf of Mexico to the Gulf. In Canadian waters the range of Atlantic bluefin tuna extends from Georges Bank, into the Bay of Fundy, along the Scotian Shelf, in the Gulf of St. Lawrence, to the Grand Banks off Newfoundland and extends from coastal waters to the boundary of Canada's Exclusive Economic Zone (DFO 2011b). The large, endothermic bluefin tuna are adapted for migration to colder waters while maintaining a high metabolic rate, which is evident in their migration into the Gulf in search of food stocks (National Oceanic and Atmospheric

Administration (NOAA) 2005). The Atlantic bluefin tuna generally follow food stocks that aggregate in the Gulf from July through November. There are two populations of bluefin tuna based on their distinct spawning areas, the Eastern Mediterranean population and the Western Gulf of Mexico population; either population can be found within the Gulf (Walli *et al*. 2009). The western Atlantic bluefin tuna spawn between mid-January and late March, with the eastern population spawning in late May. Eggs incubate for two days before emerging in a larval state (DFO 2009a). Maturity is expected to occur around age eight (DFO 2009a) with habitat range expanding with age. Adults follow Atlantic herring and Atlantic mackerel fishing grounds and are known to forage on Atlantic herring in late summer and switch to Atlantic mackerel in the fall (Walli *et al*. 2009). The location and landed weights (lbs) of Atlantic bluefin tuna from 2000-2009 can be found in Appendix M.

Atlantic Cod

Generally the Atlantic cod can be found in waters of continental shelves and slopes, inshore or offshore, with spawning typically occurring in shallow waters (SARA 2010). There is one population of Atlantic cod that could be present within the RAA which is the Laurentian South population (COSEWIC 2010b). This population of Atlantic cod has been designated as endangered under COSEWIC.

The Maritimes population, which includes five different DFO stocks (the Southern Gulf (NAFO Division 4T), the Cabot Strait (NAFO Division 4Vn), the Eastern Scotian Shelf (NAFO Divisions 4VsW), the Bay of Fundy/Western Scotian Shelf (NAFO Division 4X) and cod found in the Canadian waters of Georges Bank (NAFO Division 5Zjm) (COSEWIC 2003a)) was spilt in April 2010 into the Laurentian South population and the Southern population (COSEWIC 2010b). Both populations were designated as endangered. The Laurentian South population includes the management units 4T, 4Vn and 4VsW and the Southern population includes the management units 4X and 5Zjm. The main cause of decline of these populations of cod was also a result of overfishing. Commercial fishing efforts were reduced in the early 1990s; however, increased natural mortality and continual small catch efforts have caused the population to decline again.

Atlantic cod eggs and larvae are planktonic and the larvae are primarily zooplankton feeders; once they settle, their primary food source are benthic and epibenthic invertebrates (Scott and Scott 1988). Pelagic juveniles can occupy eelgrass beds, macroalgal habitat, sandy bottoms, cobble and rock reefs (Keats *et al*. 1985, Tupper and Boutilier 1995a, 1995b). The primary diet of juvenile cod includes pelagic crustaceans, especially zooplankton (but benthic species are also included in their diet (*e.g.*, gammarids and harpacticoids) (Grant and Brown 1998)), while inshore adult cod feed primarily on capelin (Lilly 1987), depending on the season (O'Driscoll *et al.* 2000). The distribution of cod catches during the 1993 to 2000 summer research vessel (RV) surveys can be found in Appendix M.

Atlantic Salmon

Within the RAA many rivers that have a sustained connection to the Atlantic Ocean may support Atlantic salmon (*Salmo salar*) habitat (Schaefer *et al*. 2004). There are seven salmon runs in the RAA: Balls Creek; Sydney River; Irish Brook; Southwest Brook; Big Glace Bay Lake; Mira River; and Catalone River. The major angling rivers within the RAA include the Mira River and Catalone River. Local knowledge has also indicated that there are salmon in smaller rivers and brooks located within the RAA.

In Sydney Bight, salmon return to rivers either in June or later in October, and many overwinter on the Grand Banks. Those that return in June, but do not enter rivers until October, appear to remain locally along the coast (Schaefer *et al*. 2004). Salmon stocks in the area once supported a small trap and gillnet fishery in Great Bras d'Or, St. Anns Bay and Ingonish. These stocks now only exist on a recreational level. Most of the stocks on the Atlantic coast of Nova Scotia are extirpated or are at risk of extirpation. As a result, any river that currently supports populations of Atlantic salmon is important habitat for the species. The North River salmon stock is the most important in the Sydney Bight watershed, and in Cape Breton it is second only in importance to the Margaree River. Most of the coastal zone is staging area for Atlantic salmon and should therefore be considered significant habitat (Schaefer *et al*. 2004). The Marine Environment considers Atlantic salmon habitat in marine and estuarine conditions. The Freshwater Fish and Fish Habitat Section 5.6 discusses freshwater Atlantic salmon habitat within the RAA. A map of Atlantic Salmon Rivers found within the RAA can be seen in Appendix M.

Basking Shark

The Atlantic population of basking shark has recently been assessed as a species of Special Concern by COSEWIC; it has no status under schedule 1 of SARA (SARA 2010). The basking shark is found in the western North Atlantic from northern Newfoundland south to Florida and occurs in Canadian waters from May to September (Scott and Scott 1988). The Canadian population ranges from approximately 5,000 to 10,000 individuals (COSEWIC 2009). Confirmed sightings of basking sharks in Atlantic Canadian waters can be found in Appendix M.

Blue Shark (Atlantic Population)

The blue shark is widespread and highly migratory. It has been designated as of special concern by COSWEIC. In Atlantic Canada they can be found in almost all offshore surface waters to a depth of 350 m, and peak occurrence occurs in the late summer and fall. The blue shark has a 9 to 12 month gestation period and females produce litters approximately every two years. They are opportunistic feeders and tend to eat a variety of prey including squid, birds and marine mammal carrion (COSEWIC 2006b). The distribution of blue sharks in Atlantic Canada from 1986 to 2004 can be found in Appendix M.

Porbeagle Shark

The porbeagle shark has been designated as endangered by COSEWIC. In Canadian waters, the porbeagle shark can be found from northern Newfoundland into the Gulf and around Newfoundland to the Scotian Shelf and Bay of Fundy. This shark is a pelagic species but is more commonly found on continental shelves in waters between 5°C and 10°C. Mating occurs off southern Newfoundland and at the entrance to the Gulf, between late September and November. Pregnant females are present in the area from late September through to December and are seldom seen from January through to June (COSEWIC 2004a). The distribution range of the porbeagle shark can be found in Appendix M.

Shortfin Mako

Shortfin makos are distributed globally in all tropical and temperate seas. In Canadian Atlantic waters the shortfin mako is typically associated with warm waters such as in and around the Gulf Stream. It has been recorded from Georges and Browns Bank, along the continental shelf of Nova Scotia, the Grand Banks and even into the Gulf of St. Lawrence. Shortfin mako prefer warmer water temperatures between 17°C to 22°C (COSEWIC 2006c), and as such would likely be associated with offshore Gulf Stream waters. Shortfin mako migrate north into Canadian waters during the summer to early fall following prey species such as tuna, mackerel and swordfish (COSEWIC 2006c). This species generally occurs offshore but may follow food stocks into shallower water. The historical catch data of shortfin mako from the International Observer Program between the years of 1986 - 2004 can be found in Appendix M.

Spiny Dogfish

The spiny dogfish, Atlantic population, was designated as of special concern by COSEWIC in April 2010. This small shark is abundant in Canadian waters and widely distributed in temperate regions, being most abundant in southwest Nova Scotia. Reasons for concern in Canadian waters include low fecundity, long generation time, and uncertainty regarding abundance of mature females and demonstrated vulnerability to overfishing in US waters (COSEWIC 2010c). The distribution of spiny dogfish in Atlantic Canada from the Summer RV Surveys can be found in Appendix M.

Striped Bass (Southern Gulf of St. Lawrence Population)

Striped bass occur from the St. Lawrence Estuary along the Atlantic coast to Florida, with historical breeding in five eastern Canadian rivers, including the St. Lawrence Estuary.
Two genetically-distinct (and isolated) extant populations occurring in the southern Gulf (Miramichi River) and Bay of Fundy (Shubenacadie River). Females usually spawn at age five (although they can mature at age four) and males mature at year three or four. Spawning occurs in late May or early June, primarily in freshwater, and development from egg to young-of-the-year corresponds to a gradual movement to salt water. Once yolk sacs are depleted, the larvae

feed on zooplankton for approximately one month. Immature and adult bass feed on invertebrates or fish in estuaries and coastal waters in summer and can overwinter in rivers. Striped bass school to fish and cover tens of kilometres in one day (COSEWIC 2004b).

There has been no evidence of spawning in the St. Lawrence Estuary for over two decades, nor has there been any authenticated catches of local bass in the same time period. Limiting factors include commercial and recreational overfishing and alteration of habitat. Strict harvesting regulations, followed by a complete closure in 2000 of any striped bass fishery seems to have a allowed a population recovery. The St. Lawrence Estuary population is considered extirpated and the southern Gulf population has been designated as Threatened by COSEWIC; it is not listed under SARA Schedule 1 (COSEWIC 2004b).

It is known that Big Glace Bay supports a small run of striped bass, but little specific data is available. They are anadromous and spawn from May to June when temperatures are 15°C. They prefer to spawn in tidal bores, or in river areas that are tidally influenced (CBCL 2008).

White Shark

White sharks are designated as Endangered under SARA. They are rare (only 32 records in over 132 years for Atlantic Canada) in Canadian waters (which represent the northern-most edge of their range) and are recorded mostly in the Bay of Fundy area (COSEWIC 2006d). They are extremely rare to occur as far north as the RAA. Occurrences of white sharks in Canadian waters can be found in Appendix M.

Winter Skate (Eastern Scotian Shelf population)

The Eastern Scotian Shelf population of the winter skate has been designated as threatened under COSEWIC. The winter skate is endemic to the Northwest Atlantic and in Canadian waters this species tends to be concentrated in three areas, the southern Gulf, the eastern Scotian Shelf, and the Canadian portion of Georges Bank. This is a bottom-dwelling species that prefers sand and gravel bottoms and occurs at depths up to 371 m. However, there are more commonly found at a depth of 111 m. Spawning occurs during late summer to early fall and their diets consist mainly of various shellfish, amphipods and small fish (COSEWIC 2005a). The population of winter skate in Atlantic Canadian waters can be found in Appendix M.

Wolffish

Three species of wolffish, each of which have been designated a status under SARA Schedule 1, can be found in the RAA. The northern and spotted wolffish have been listed as threatened under SARA Schedule 1; the Atlantic wolffish is considered of special concern.

The northern wolffish can be found in cold Continental Shelf waters at depths up to 900 m but prefer depths of approximately 100 m. Spawning occurs in fall and females can lay up to 27,000 extremely large eggs. This species is non-migratory and usually make nests to guard their eggs. They feed on benthic invertebrates (Kulka *et al.* 2007).

Northern wolffish in the Northwest Atlantic is treated as a single population and is listed as threatened on Schedule 1 of SARA due to the rapid decline along the northeast Newfoundland/ Labrador Shelf and the Grand Banks. Northern wolffish occur along the slope of the Laurentian Channel, along the edges and slopes of the Labrador shelf, northeast Newfoundland shelf and in low numbers on the Grand Banks (Kulka *et al*. 2004a). Abundance off northeast Newfoundland is thought to have declined by 98 percent from 1978 to 1994. The number of locations where the species occurs has also declined (SARA 2010). The distribution of the northern wolfish caught in the Summer RV Survey from 1970 to 2010 can be found in Appendix M.

The spotted wolffish is a bottom-dwelling predatory fish that can be found in cold Continental Shelf waters, at depths ranging from 50 to 600 m. Spawning occurs in summer (Kulka *et al*. 2007). Spotted wolffish are treated as a single population in the Northwest Atlantic and are listed as threatened on Schedule 1 of SARA, due to the rapid decline along the northeast Newfoundland/Labrador Shelf and the Grand Banks. In the western North Atlantic, they occur primarily off northeast Newfoundland. Scientific surveys indicate a 96 percent decline in the Canadian population over 21 years. The distribution of the spotted wolfish caught in the Summer RV Survey from 1970 to 2010 can be found in Appendix M.

The Atlantic (or striped) wolffish inhabits cold, deep waters with rocky or hard clay bottoms along the continental shelf. Within the western Atlantic Ocean, this species can be found in the Strait of Belle Isle and in the Gulf. Spawning typically occurs in September in shallow waters. Juvenile fish however remain in deeper waters. Their diet is composed of hard shelled benthic invertebrates and smaller fish (Kulka *et al*. 2007). The distribution of the Atlantic wolfish caught in the Summer RV Survey from 1970 to 2010 can be found in Appendix M.

Atlantic wolffish is listed as a species of special concern on Schedule 1 of SARA. They occur further south and in greater abundance than the northern and spotted wolffish. They occur along the south coast and St. Pierre Bank, along the Labrador and northeast Newfoundland shelves and on the Grand Banks (Kulka *et al*. 2004a). Available data indicate populations in Canadian waters have declined by 87 percent from the late 1970s to the mid-1990s. As well, locations where the species occur have declined and the range where the species is abundant may be shrinking. Even though it has measurably declined, it is thought to be very widespread and to still exist in relatively large numbers (SARA website 2010).

A Recovery Strategy for northern and spotted wolffish, and Management Plan for Atlantic wolffish, has been developed to increase the population levels and distribution of the northern, spotted and Atlantic wolffish in eastern Canadian waters such that the long-term viability of these species is achieved (Kulka *et al*. 2007). Five primary objectives have been identified to achieve the long term viability of the three wolffish species. The primary objectives relate to activities that may be mitigated through human intervention and each objective is designed to achieve the goal of increasing population levels and distribution of the wolffish species such that long-term viability is ensured. Details of this recovery plan can be found in the northern and spotted wolffish Recovery Strategy and Atlantic wolffish Management Plan report (Kulka *et al.* 2007).

5.7.2.2.2 Marine Mammals

There are six species of marine mammals that could potentially be found within the RAA that are considered at risk. The status of these species is presented in Tables 5.7.3 and 5.7.4.

Blue Whale (Atlantic Population)

The Atlantic population of the blue whale has been listed as endangered under SARA. During spring, summer and fall, the blue whale can be found along the north shore of the Gulf and off eastern Nova Scotia. In the summer, they can also be found off the south coast of Newfoundland and in the Davis Strait. They typically migrate south for the winter. However, they have a tendency to remain in the Gulf during milder winters with light ice cover. A 2007 survey resulted in an estimated abundance of 16 blue whales in the entire Canadian survey (Lawson and Gosselin 2009). They inhabit both coastal and open ocean waters and are frequently observed in highly productive coastal waters where there is an abundance of krill, their primarily food source. Blue whales can dive for on average of 5 to 15 minutes after breathing at the water’s surface. They mate and give birth during fall and winter in warmer southern waters. The blue whale is one of the largest and loudest (calls of 186 dB) animals in the world (SARA 2010).

The major factor responsible for the reduction in abundance of the blue whale was a result of historical whaling activities. It has been estimated that whaling reduced the blue whale population by approximately 70 percent, and that there are likely only 250 mature blue whales present in the Northwest Atlantic population (Beauchamp *et al*. 2009). Twelve threats to the north Atlantic blue whale were identified in the 2009 Blue Whale Recovery Strategy and include anthropogenic noise – acoustic degradation and changes in behaviour, food availability, contaminants, collisions with vessels, whale watching, anthropogenic noise – physical damage, accidental entanglement in fishing gear, toxic algal blooms, toxic spills, whaling, ice and predation. Those of highest concern include anthropogenic noise (acoustic degradation and changes in behaviour) and food availability. A number of recovery actions have already been undertaken, including blue whale protection programs and habitat protection measures and awareness, one of which includes the development of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*. Details of this recovery plan can be found in the Blue Whale Recovery Strategy Report (Beauchamp *et al*. 2009).

Harbour Porpoise (Northwest Atlantic Population)

The Northwest Atlantic population of the harbour porpoise is widely distributed over continental shelves and is made up of three sub-populations found in Canadian waters, Newfoundland-Labrador, Gulf and the Bay of Fundy/Gulf of Maine. A 2007 survey resulted in an estimated abundance of 3,629 harbour porpoise in the Gulf and Scotian Shelf combined (Lawson and Gosselin 2009). This population of the harbour porpoise has been designated as of special concern under COSEWIC. This species is well adapted to cold water and often inhabits bays and harbours during summer. They feed upon a variety of small fishes including cod, herring, hake, capelin and sand lance (SARA 2010).

Humpback Whale

Like most whale species, the humpback whale migrates to high-latitudes during the summer and low-latitudes during the winter months (Winn and Reichley 1985). During the summer, approximately 900 humpbacks are thought to use the Southwest Shoal of the Grand Banks to feed on capelin (Whitehead and Glass 1985). The Newfoundland population of humpback whales is estimated at 1,700 to 3,200 individuals (Whitehead 1982), while the Northwest Atlantic population is estimated at 5,505 individuals (Katona and Beard 1990), and the entire North Atlantic population is estimated at approximately 11,570 individuals (Baird 2003).

Humpbacks are common in coastal waters, occurring in groups of several individuals while feeding on capelin, herring, krill and shrimp. Humpback whales undergo seasonal migrations from high-latitude feeding areas in the summer (*i.e.*, Canadian Waters) to low-latitude breeding and calving grounds (COSEWIC 2003b).

Humpbacks from western and eastern North Atlantic use the West Indies as the primary breeding and calving grounds with small numbers breeding and calving in the Cape Verdes (COSEWIC 2003b). There are three feeding stocks located in Eastern Canada; the Gulf of Maine, the Gulf and the Newfoundland and Labrador stocks. There is some interchange between feeding stocks and juveniles from all three stocks mix in mid-latitude feeding areas.

Killer Whale

The Northwest Atlantic population of the killer whale is designated as special concern under COSEWIC. Little information regarding the distribution of the killer whale in the RAA has been documented, but they are widespread in the area (COSEWIC 2008). The distribution seems to be dependent on the availability and accessibility of their prey. The killer whale can withstand significant changes in salinity, temperature and turbidity.

North Atlantic Right Whale

The North Atlantic right whale is a migratory species that typically inhabit coastal waters and spend their summers feeding in cooler waters and in warmer waters during winters. This species has been listed as endangered under Schedule 1 of SARA. Two stocks of the North Atlantic right whale can be found in Canadian waters, the eastern North Atlantic stock and the western North Atlantic stock. The western North Atlantic stock can be found from the coast of Florida to Newfoundland and Labrador and in the Gulf. They feed primarily on zooplankton (SARA 2010). A 2007 survey did not identify any North Atlantic right whales on the Scotian Shelf (Lawson and Gosselin 2009).

Since commercial whaling has ended, threats to the abundance of the North Atlantic right whale are a result of strikes by vessels and entanglements with fishing gear most commonly, as well as disturbance and habitat reduction (Brown *et al*. 2009). The 2009 North Atlantic Right Whale Recovery Strategy states that where there is limited knowledge on the actual abundance of this species, long term abundance targets cannot be determined and instead a goal to achieve an increasing tread in population abundance over three generations was identified. The objectives that were identified to meet this goal included: reducing mortality and injury as a result of vessel strikes and fishing gear interactions; reducing injury and disturbance as a result of vessel presence or exposure to contaminants and other forms of habitat degradation; monitoring population and threats; increasing the understanding of life history characteristics, low reproductive rate, habitat and threats to recovery through research; supporting and promoting collaboration for recovery between government and agencies; and developing and implementing educational programs. Details regarding the strategies that are in place to meet such objectives can be found in the North Atlantic Right Whale Recovery Strategy Report (Brown *et al*. 2009).

Fin Whale (Atlantic Population)

The Atlantic population of the fin whale has been listed special concern under SARA. This species tends to make seasonal migrations from low latitude areas during the winter to high latitude summer feeding areas. Summer concentrations of the fin whale can be found in the Gulf, on the Scotian Shelf, in the Bay of Fundy, and in the nearshore and offshore waters of Newfoundland and Labrador (COSEWIC 2005b). Little is known about their overwintering or breeding areas. A 2007 survey resulted in an estimated abundance of 28 fin whales in the Gulf (Lawson and Gosselin 2009).

5.7.2.2.3 Sea Turtles

There are two species of sea turtles that could potentially be found within the RAA that are considered at risk. The status of these species is presented in Tables 5.7.3 and 5.7.4.

Leatherback Sea Turtle

The leatherback sea turtle is a migratory turtle that breeds in tropical and subtropical waters and feeds in temperate waters. The leatherback turtle has been listed as endangered under Schedule 1 of SARA. These turtles spend the majority of their life at sea but come ashore to nest and lay eggs. Leatherback turtles nest from November to April and are typically present in Canadian waters from June to November to forage (Atlantic Leatherback Turtle Recovery Team 2006).

Loggerhead Sea Turtle

The loggerhead sea turtle is the largest hard-shelled sea turtle in the world and the most abundant in North American waters. Globally, there are an estimated 43,000 to 45,000 nesting females (Spotila 2004). Its distribution is largely constrained by water temperature and it does not generally occur where the water temperature is below 15°C (Brazner and McMillan 2008). There are limited estimates of the density of loggerhead turtles offshore western Newfoundland (LGL 2005). Loggerheads can migrate considerable distances between near-equatorial nesting areas that are occupied from late April to early September (Spotila 2004) and temperate foraging areas, some moving with the Gulf Stream into eastern Canada waters during the summer and fall (Hawkes *et al*. 2007). Available information indicates a seasonal population of juvenile loggerheads in Atlantic Canada (Witzell 1999; COSEWIC 2010d) but the number occurring in Canadian waters is unknown. While foraging at sea, loggerheads likely consume gelatinous zooplankton and squid (Spotila 2004); there is no diet information available for Canadian waters (DFO 2010c). Most loggerhead records offshore Newfoundland have occurred in deeper waters south of the Grand Banks and sightings have extended as far east as the Flemish Cap (COSEWIC 2010d). The loggerhead sea turtle was designated as endangered under COSEWIC in April 2010. This species is threatened by commercial fishing activities, loss and degradation of nesting beaches, marine debris, chemical pollution, and illegal harvesting of eggs and nesting females (COSEWIC 2010d).

5.7.2.3 Oceanography

5.7.2.3.1 Bathymetry

Data were collected from the Canadian Hydrographic Service's nautical charts 4367 (Flint Island to Cape Smokey) and 4375 (Guyon Island to Flint Island) to create a bathymetric map of the Project area (CBCL 2012) and which is provided in Figure 1 in Appendix M. Morien Bay is a relatively shallow bay with an average depth of about 10 to 15 m, chart datum. The barge load-out facility extends from shore to a water depth of approximately 7 m. Mira Bay is slightly deeper with a maximum water depth of about 25 to 30 m. The transshipment mooring location is in about 24 m water depth in Mira Bay.

5.7.2.3.2 Ocean Currents

In general, water currents in the area of the Project are extremely variable in time and space, and when coupled with a weak tidal influence, this makes them difficult to predict. In the summer months tides account for less than 30 percent of the total current energy, the remainder of the energy is due mainly to winds and large scale coastal dynamics. During the winter months this tidal influence is even less (CBCL 2012). Current data collected in the past indicated that there is a weak eastward drift along the New Waterford-Glace Bay coast line with speeds of around 1 cm/s (CBCL 2012). Nearer to shore, shoreward of breaking wave crests, currents will include an along shore component due to the breaking waves. This effect can be significant during the periods of high wave energy in the fall and winter.

CBCL conducted current meter measurements as part of the initial Donkin environmental assessment work in 2006. The measurements were taken at Schooner Pond Cove and South Head. These measurements concluded:

- South Head experiences stronger currents, typically 0.2-0.3 m/s on average compared to 0.1-0.15 m/s at Schooner Pond Cove;
- the non–tidal energy is significant at both sites (>30 percent); and
- the currents are generally aligned with the shoreline.

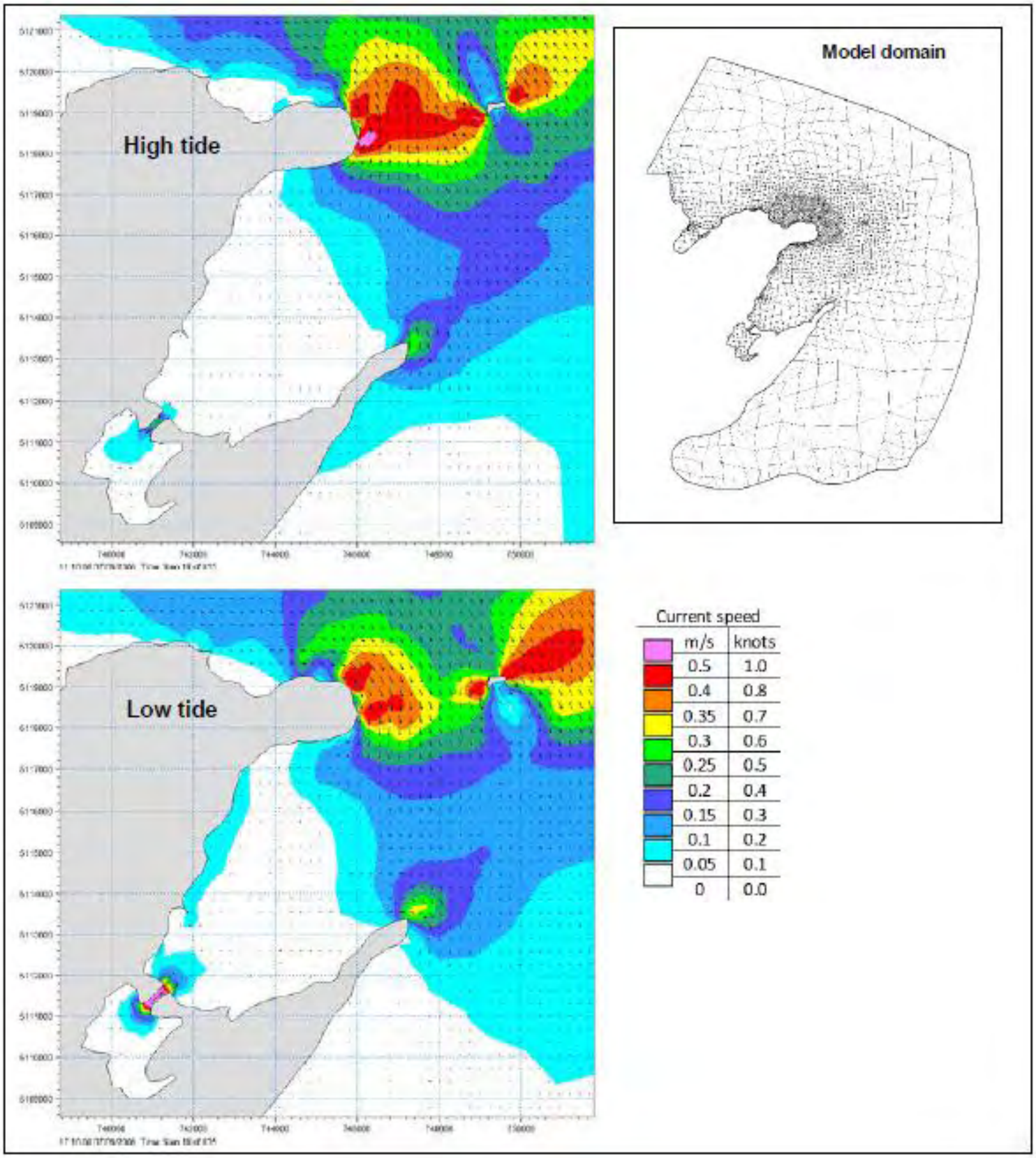
On December 17, 2011 Stantec conducted water current profiling along transects in the southern nearshore environment of the Donkin Peninsula, through Morien Bay and around South Head, and at the transshipment mooring location in Mira Bay during both ebbing and flooding tides. The current profiling transects, conducted from a moving vessel with an Acoustic Doppler Current Profiler (ADCP), covered the footprints of the barge load-out facility, the transshipment mooring location, and the barge route between the two locations. During the current profiling transects, data on water current direction and magnitude were collected at 0.5 m water depth intervals throughout the water column, except for near-surface and at the bottom because of instrument limitations. ADCP data during a segment of the flood tide transect are not available due to instrument recording error. In addition to current profiling, water depth was measured through the averaging of the four acoustic receivers on the ADCP. Winds on December 17, 2011 were from the northwest with a mean velocity of 12 km/h between 09:00 and 17:00 during the survey.

An average of the surface currents during the flood tide (2.5 hours after low tide) indicates a general weak flow of 0.09 m/s in the easterly to south-easterly direction at the barge load-out wharf in waters 5 m to 7 m deep, chart datum (Figure 2, Appendix M). The bottom currents were even weaker with no discernible pattern to the flow direction. Within the water column the currents were generally stronger at the surface and decreased with depth, and varying in current direction (Figure 3, Appendix M). Spatially, the currents increased in magnitude in the southeasterly direction with proximity to South Head (Cape Morien) along the barge route. The currents then veer to the southwest and increase even more in strength to approximately 0.4 m/s once past South Head and along the barge route, suggesting increased exposure to larger-scale coastal currents and which are likely affected by the steeper bathymetry surrounding South Head (Figure 4, Appendix M). At the transshipment mooring location, current measurements were taken 1 hour before high tide. The currents in this area are stratified (Figure 3, Appendix M), with currents in a surface layer about 7.5 m thick flowing in a southeasterly direction and surface currents averaging about 0.19 m/s (Figure 4, Appendix M). The mid- to bottom currents are somewhat weaker (average bottom speed of 0.12 m/s) and tend to flow in a northwest direction and completely opposite to that of the water currents in the surface layer.

During an ebbing tide (2 hours after high tide), the surface current velocity is still weak at the barge load-out facility but slightly higher at 0.11 m/s than for a flooding tide and also flowing in a easterly direction (Figure 5, Appendix M). Bottom currents, however, are higher with the ebb tide at 0.14 m/s than the surface currents and the bottom currents for a flooding tide, and flow with a more uniform direction towards the north-northwest (Figure 5, Appendix M). The currents for an ebbing tide are also slightly higher throughout the water column at the barge load-out facility and at the transshipment location (Figure 6, Appendix M). At the transshipment location, as for the flooding tide, the currents are stratified with the upper and mid currents (0-10 m) flowing in a southeasterly direction with an average of 0.23 m/s at the surface (Figure 7, Appendix M). The bottom currents were generally weak and flowing in a northerly direction and similar to bottom currents for a flood tide. The currents along the barge route are also similar to those for a flooding tide with respect to flow in a southwesterly direction in Mira Bay, but slightly weaker in strength at the surface than for a flooding tide.

CBCL has modeled peak tidal currents for the existing conditions around the Donkin area (CBCL 2012). The tidal currents are stronger (>0.5 m/s) around the tip of the Donkin Peninsula and weaker towards Morien Bay and Mira Bay (Figure 5.7.2). The modeled weaker currents in Morien and Mira Bays are supported by the measured current data collected in the field.

Figure 5.7.2 Modeled Peak Tidal Currents for Existing Conditions

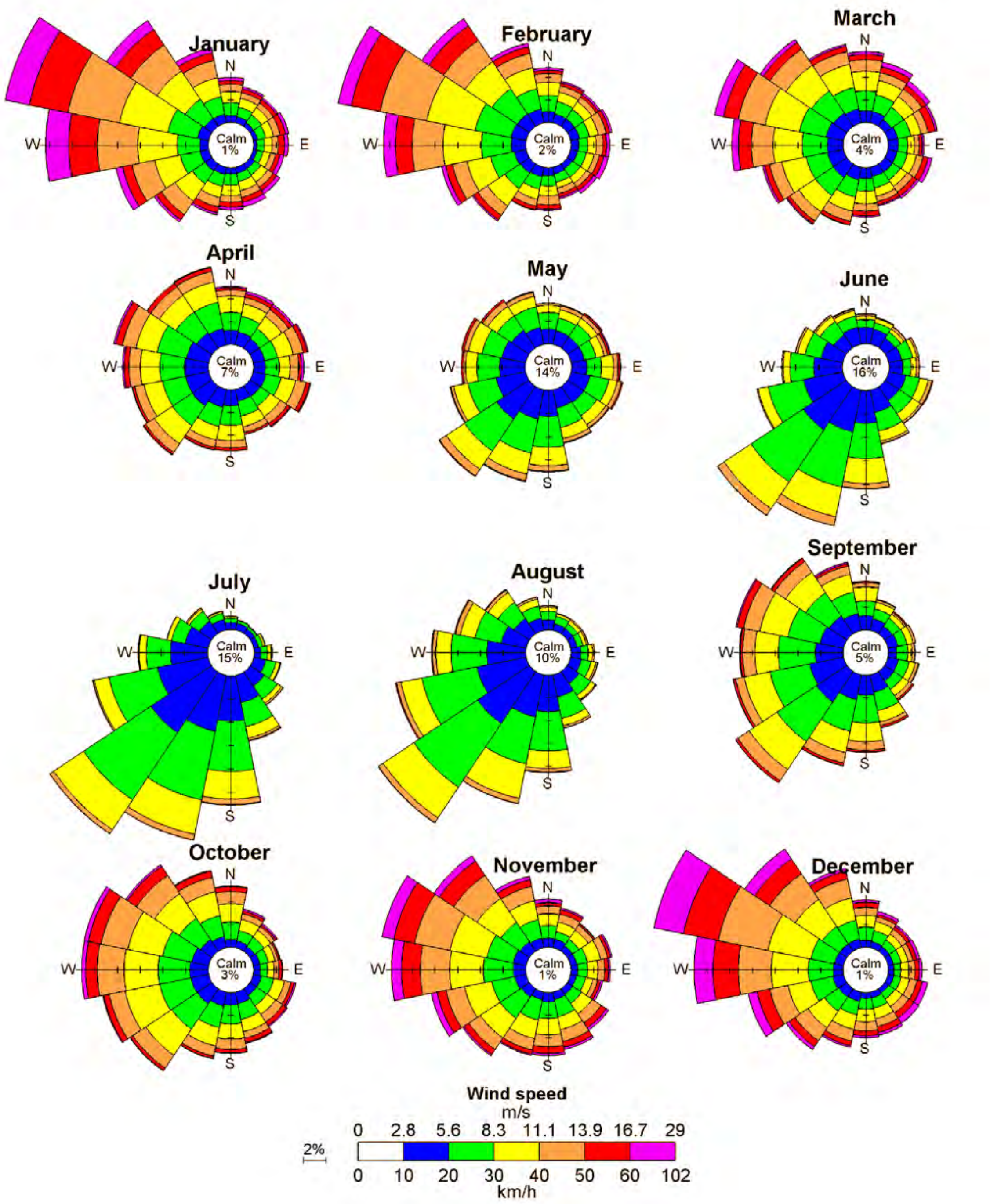


CBCL 2012.

5.7.2.3.3 Wind and Waves

The wind data used for analysis are from a recent 56 year wind and wave hindcast referred to as ‘MSC50’ (CBCL 2012). This data set spans from January 1954 to December 2009 and contains hourly time series of wind and wave measurements for an offshore location at latitude 46.1°N and longitude 59.6°W, east of the Project location. Prevailing winds in the area are from the southwest in the summer months and from the west-northwest in the fall and winter seasons. Winds in the summer tend to be below 30km/h, with fall and winter winds being at much higher velocities. Monthly offshore wind directional statistics can be seen in Figure 5.7.3 below.

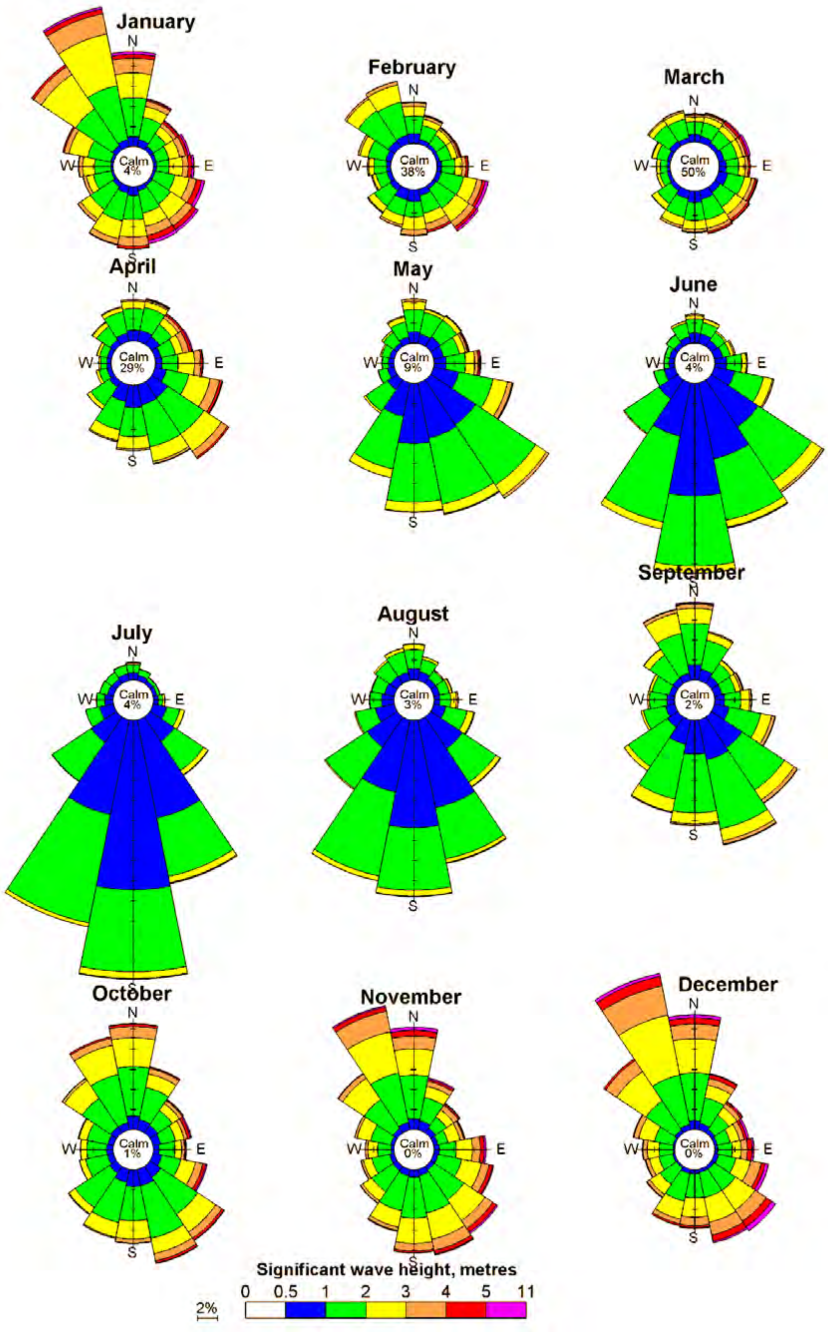
Figure 5.7.3 Monthly Offshore Wind Directional Statistics



CBCL 2012.

Offshore waves are influenced by ice cover, bathymetry, and wind. In the summer the prevailing wave climate consists of long-period swells from the south, with wave heights typically under 2 m. During the winter months there are extended periods of calm created by ice cover. The months with the largest waves are from November to January, when there are more frequent storms coming from a northerly direction, resulting in waves with heights ranging from 2 m to 10 m. A depiction of these monthly trends is presented in Figure 5.7.4.

Figure 5.7.4 Monthly Offshore Wave Height Statistics



CBCL 2012.

CBCL has modelled return periods for extreme wave heights (1, 10, 50, 100-year) based on storm peaks from the southeast quadrant (90° to 180°) using a method referred to as "Peak-Over-Threshold". A most probable peak period was derived from extreme wave heights from storm peaks. The results for the extreme offshore wave heights and period on the yearly, 10 year, 50 year and 100 year scale are provided in Table 5.7.5.

Table 5.7.5 Peak Offshore Wave Height and Period Predictions on a Temporal Scale of 1, 10, 50, and 100 Year Return Period

Return Period (Years)	Significant Wave Height (m)	Peak Period (seconds)	Wind Speed (m/s)
1	6.1	10.5	18.1
10	7.7	12.0	21.3
50	9.4	13.2	24.1
100	10.3	13.7	25.2

Adapted from: CBCL 2012.

5.7.2.3.4 Ice

A numerical wave model for near-shore transformation was used to transfer offshore wave parameters to the potential breakwater and transshipment sites. Sensitivity analyses on the direction of input wind and wave parameters indicated that the worst-case conditions in this region are obtained with an ESE offshore direction. The wave transformation pattern for the 50-year storm is presented on Figure 5.7.5 (simulated over the entire model domain) and Figure 5.7.6 (zoomed on the barge loading site). This analysis including information presented in Table 5.7.6 assisted in the selection of the preferred breakwater site.

Figure 5.7.5 Modelled 50-Year Return Storm Conditions (Offshore Hsig = 9.4 m, Tp = 13.2 s)

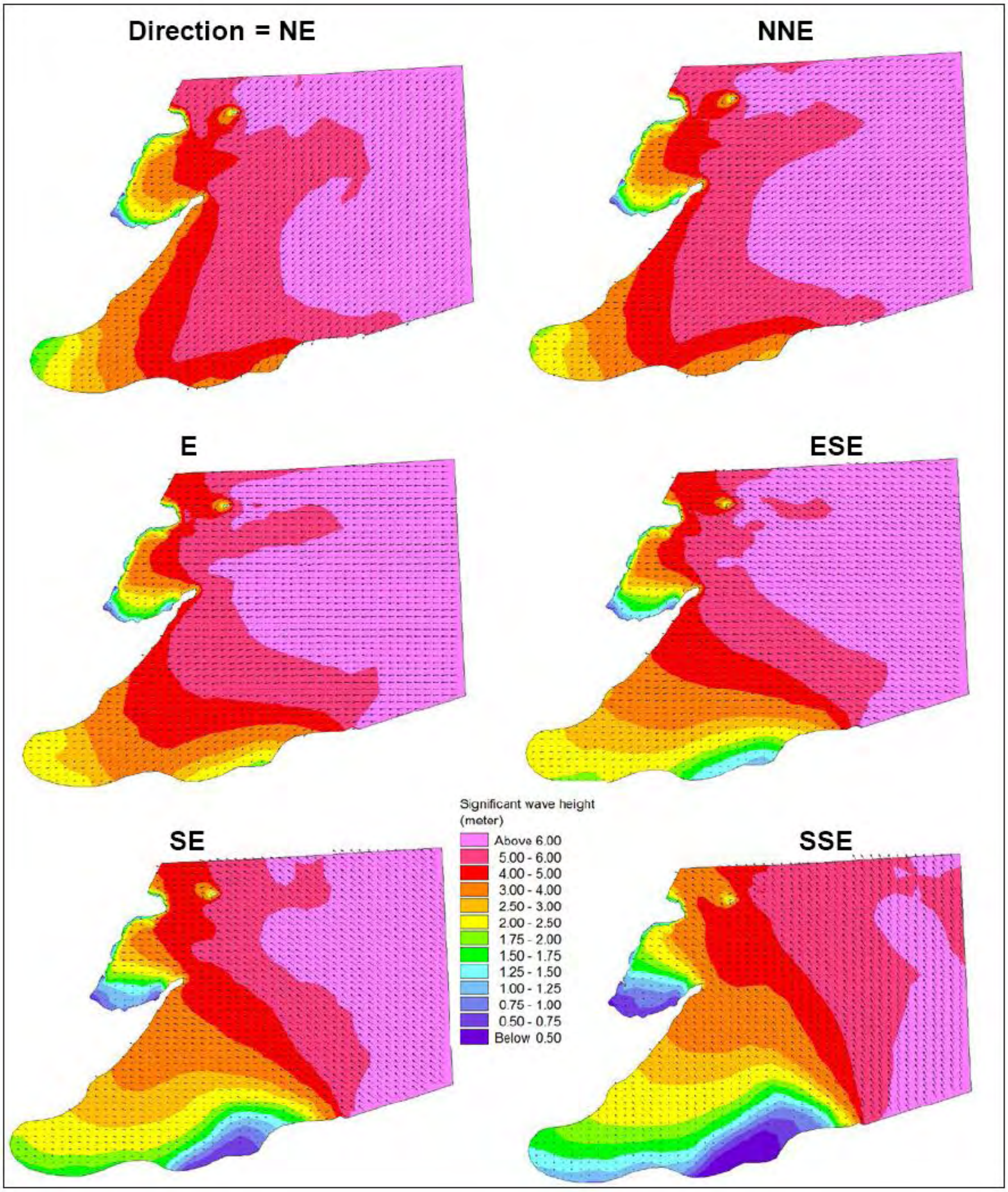


Figure 5.7.6 Modelled 50-Year Return Storm Conditions at Barge Loading Sites

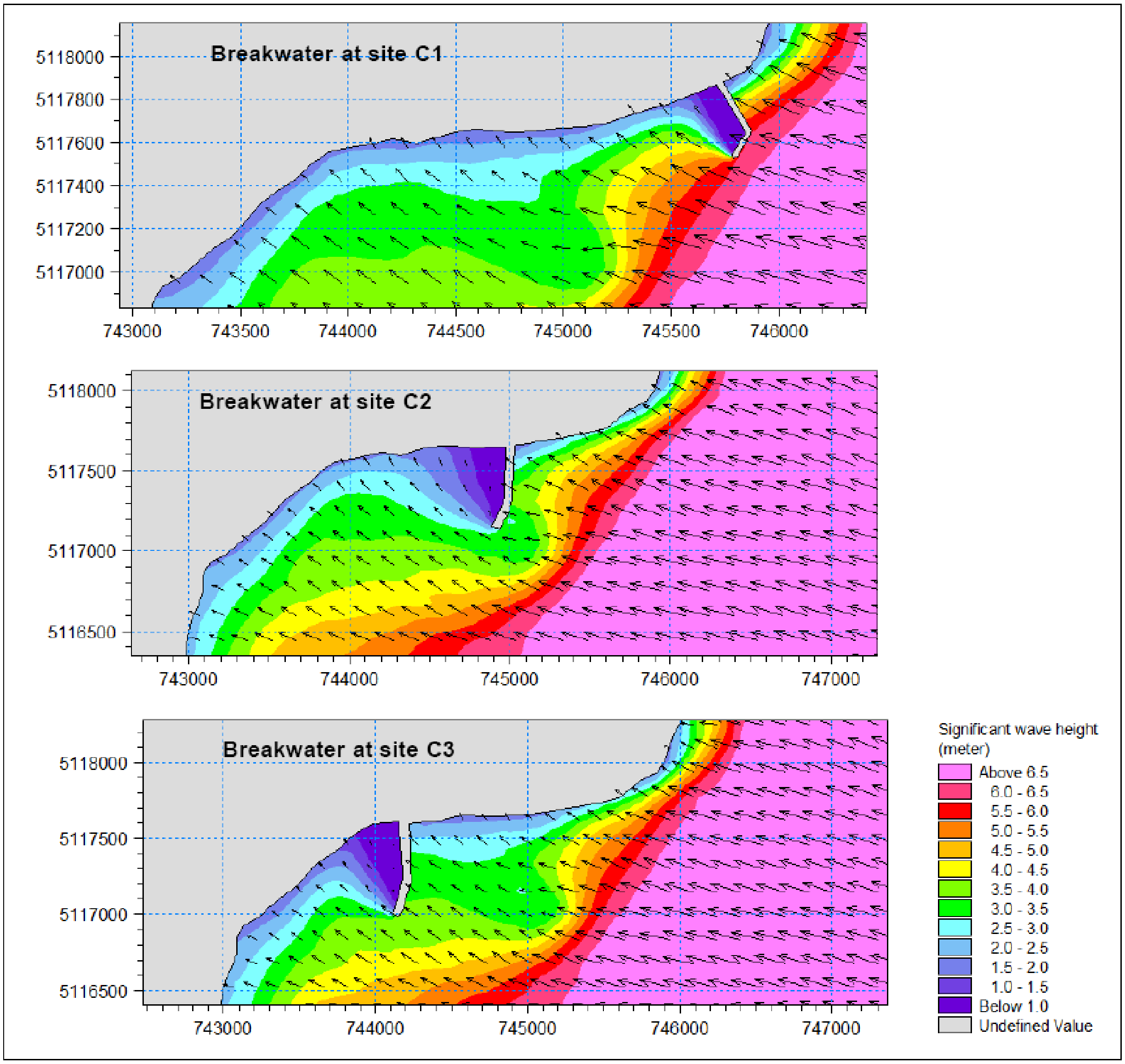


Table 5.7.6 Modelled Extreme Wave Parameters Incident to the Breakwater

Return Period (years)	Offshore Hsig (m)	Associated Parameters		Nearshore Hsig (m) from ESE		
		Peak Period	Winds Speed (m/s)	C1	C2	C3
1	6.1	10.5	18.1	4.9	3.3	3.2
10	7.7	12.0	21.3	5.8	3.5	3.5
50	9.4	13.2	24.1	5.2	3.7	3.7
100	10.3	13.7	25.2	6.4	3.8	3.8

Source: CBCL 2012

Environment Canada has recorded weekly data for ice cover on the east coast of Canada for a period of 30 years from 1981 to 2010 (Environment Canada 2010a). During this period of time, ice cover in the Project location begins around January 1 and fully retreats by May 14 on any given year. A summary of ice conditions in and around the Project location is provided below in Table 5.7.7, including the median of predominant ice type when ice is present, and the frequency of presence of sea ice.

Table 5.7.7 Average Weekly Ice Conditions for the Project Location (1981-2010)

Sea Ice Cover from 1981-2010		
Week	**Median of Ice Type**	**Frequency of Sea Ice Presence**
January 1	New Ice	1-15%
January 8	No Ice	0%
January 15	No Ice	0%
January 22	New Ice	1-15%
January 29	New Ice	16-33%
February 5	Grey Ice	16-33%
February 12	Grey Ice	34-50%
February 19	Grey Ice	34-50 %
February 26	Grey White Ice	51-66%
March 5	Thin 1st Year Ice	51-66 %
March 12	Thin 1st Year Ice	34-50%
March 19	Thin 1st Year Ice	51-66%
March 26	Thin 1st Year Ice	51-66%
April 2	Thin 1st Year Ice	16-33%
April 9	Thin 1st Year Ice	16-33%
April 16	Thin 1st Year Ice	16-33%
April 23	Thin 1st Year Ice	16-33%
April 30	Medium 1st Year Ice	1-15%
May 7	Medium 1st Year Ice	1-15%
May 14	No Ice	0%

Environment Canada 2010a

5.7.2.3.5 Water Temperature, Salinity and Dissolved Oxygen

The water temperature, salinity and dissolved oxygen data collected by Stantec on December 15, 2011 at the water column profiling stations in Morien and Mira Bays are summarized in Figures 8 to 10 in Appendix M. Stations 1, 2 and 3 were located within the transshipment mooring location in approximately 24 m of water (refer to Figure 1, Appendix M). Stations 4, 5 and 6 were conducted within the proposed footprint of the barge load-out wharf in approximately 7 m of water.

The study areas exhibit a narrow range of surface and bottom water temperatures across the profiling stations (Figure 8, Appendix M). Surface temperatures ranged from 5.2°C to 5.6°C and bottom temperatures ranged from 5.2°C to 5.5°C. No strong vertical thermal stratification was observed at any station, suggesting the water column is well mixed. The general trend in the footprint for the barge load-out wharf was a minor decrease in water temperature with increasing water depth at the time of the water profiling (December 2011). The water temperature at the transshipment location was consistent from the surface to the seafloor for all stations.

The general trend in salinity observed at all stations was an increase in salinity with increasing water depth (Figure 9; Appendix M). A narrow salinity range was observed across the six sampling stations at the time of the survey (29.79 – 29.96 psu and 29.75 – 30.00 psu, surface and bottom salinities, respectively).

Dissolved oxygen was observed to follow two trends. Within the footprint of the barge load-out wharf the trend was increasing dissolved oxygen with increasing depth (Figure 10, Appendix M). The surface dissolved oxygen concentrations ranged from 10.09 to 10.20 mg/L whereas bottom concentrations ranged from 10.19 to 10.25 mg/L. At the deeper stations at the transshipment location the dissolved oxygen was observed to decrease with depth. The surface dissolved oxygen concentrations ranged from 10.34 to 10.36 mg/L while bottom dissolved oxygen concentrations ranged from 9.78 to 10.25 mg/L.

5.7.2.4 Marine Habitat

5.7.2.4.1 Sydney Bight

The RAA covers a portion of the Sydney Bight including the coastal waters of eastern Cape Breton Island that extends from Scatarie Island to Sydney Harbour and which is illustrated in Figure 5.7.1. The RAA is bordered by the deeper waters (>100 m) of the Laurentian Channel to the Northeast and by Cape Breton Island to the Southwest. The majority of the area is fairly shallow with respect to water depths, with most of the area being less than 100 m in water depth, with the exception of a deeper section of 100 m to 200 m to the Northeast (Schaefer *et al*. 2004). The RAA can be categorized by its prominent physiographic features which include: the Gutter, a narrow path of deep water off the Cape Smokey/Wreck Cove area; the Edge, a 200 m isobath where the Laurentian Channel drops off to deeper depths; White Point Bank, a sandy bank off Aspy Bay; and Smokey Bank, a large sandy bank in the eastern portion of Sydney Bight. The benthic habitat of the RAA is relatively flat and slopes gradually to form St. Anns Bank, which is the only major bank in the inner shelf zone of Nova Scotia. At water depths shallower than 100 m, sediments consist of a sand and gravel mixture through which bedrock is exposed. At water depths above 100 m the sediment consists mainly of Sambro Sand, which is a sand containing a small percentage of silt, clay and gravel.

The coastline of the RAA contains a variety of features, which play an important role as significant habitat for many species of flora and fauna in the area. The rocky exposed shores provide habitat for subtidal flora species, which provide habitat for many species of commercial and non-commercial fish and invertebrates (Schaefer *et al*. 2004). The area is an important spawning, nursing, migratory, and overwintering area for many species of finfish and invertebrates as well as being frequented by species of whales and sea turtles. Leatherback sea turtles have been known to forage in areas along the coastline of Cape Breton’s eastern shore. The area is also host to a commercially important and abundant lobster fishery. The coastal islands in the area are used as breeding grounds for seabirds and seals. Estuaries in the area, including Port Morien, Glace Bay, and Lingan Bay, contain highly productive salt marshes and eelgrass beds that are important stop-over areas for migratory birds.

5.7.2.4.2 Coastal Habitats

The Port Morien to Point Aconi coastline consists mainly of sandstone with exposed coal seams. Plant fossils can be found along the shales on beaches in the area (Schaefer *et al*. 2004). Along the coastline of northwest Sydney, there are bays and narrow inlets which connect to the Bras d’Or Lakes. The St. Anns Bay to Aspy River area contains rich tidal marshes and scattered ponds containing a diverse aquatic fauna.

The shoreline on the southern face of the Donkin Peninsula is characterized by tall exposed sandstone cliffs. At the base of the cliffs narrow, rocky beaches provide habitat for brown algae, such as *Fucus* spp. The intense wave action along this shore likely reduces the potential for abundant algal growth. The shoreline observed adjacent to the transshipment location is predominantly sheer, rock face cliffs, with no beaches. The angular bedrock slopes into the water making attachment by algae difficult. During the survey period in fall 2011, wind and wave action, as well as the presence of reefs, prevented closer inspection of the shoreline.

Photo 5.7.1 illustrates an overall representation of the shoreline characteristics observed in Morien Bay and adjacent to the barge load-out wharf and barge swing circle.

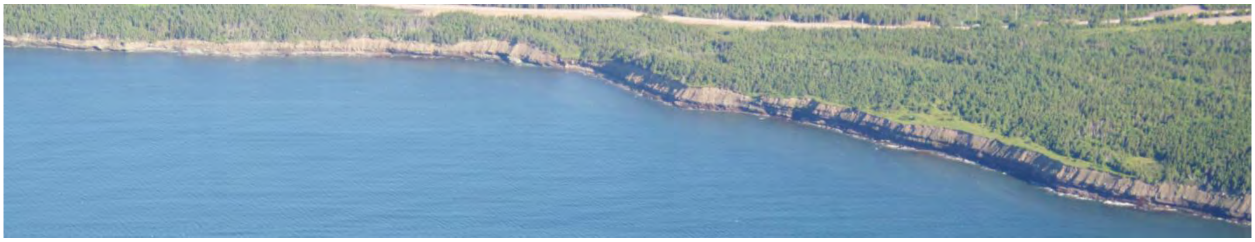


Photo 5.7.1 Aerial photo of the shoreline adjacent to the barge load-out wharf and barge swing circle facing northwest.

Photos 5.7.2 and 5.7.3 are panoramic photos to illustrate a representation of the shoreline characteristics observed at the barge load-out wharf and adjacent to the barge swing circle and transshipment location taken from a vessel.

The shoreline within the proposed footprint for the barge load-out wharf could be described as a very narrow beach at the base of steep cliffs composed of sandstone with an overlying bed of till. The steep cliffs at this location are estimated at 15 m high. The beach is composed of material eroding from the cliffs and predominantly comprised of boulder-sized substrate. The beach foreshore was less than 5 m in width in the proposed footprint of the barge load-out facility and in most areas the cliffs extended into the subtidal zone. There were no anthropogenic structures observed along the shoreline during the survey of the proposed footprint for the barge load-out facility. Photograph 5.7.2 illustrates a representative section of the shoreline at the barge load-out facility.

Photo 5.7.2 Shoreline at the proposed barge load-out facility facing North.

The shoreline adjacent to the proposed barge swing circle location associated with the barge load-out facility, is also a steep cliff composed of sandstone with an shallow overlying bed of till. The steep cliffs are approximately 15 m high and extend directly into the subtidal zone. No algal species were observed at the time of the survey though vegetation was observed on the cliffs.

Steep cliffs composed of sandstone with an overlying bed of till dominate the shoreline adjacent to the transshipment location (Photo 5.7.3). The steep cliffs at this location are estimated at 25 m high. No beach was observed along this portion of shoreline, with the cliffs extending into the subtidal zone. There were no anthropogenic structures observed during the survey of the transshipment mooring location.

Photo 5.7.3 Shoreline adjacent to the transshipment location

5.7.2.4.3 Benthic Habitats

A benthic habitat survey and sediment chemistry program was completed in the PDA between December 13 and 15, 2011 by Stantec. Eight transects on the seabed were surveyed using a remotely operated vehicle (ROV) camera and operated from a vessel. These transects were laid in the footprint of the barge load-out facility and the transshipment location (Figure 1, Appendix M), covering 8,220 m^2 of surveyed habitat. Sediments were collected with a grab sampler at the transshipment mooring location and attempts were made in the footprint of the barge load-out facility but which were unsuccessful because of the presence of large-diameter rocks and hard substrate.

A summary of the results of the marine benthic habitat survey indicate that the substrate within the footprint of the barge load-out wharf and barge swing circle mooring is predominantly rocky with rocks ranging from cobble (3 – 13 cm dia.) to rubble (14 – 25 cm dia.) and which appear to be embedded in gravel (Figure 11, Appendix M). Macroflora coverage is between 0 – 100 percent coverage with *Fucus* and Irish moss as the predominant seaweed in water depths up to 7.8 m. Only one Lobster was observed at one point along one transect during the benthic habitat surveys (Transect A, Figures 1, 12 Appendix M; Photo 5.7.4), even though the habitat characteristics were similar to the other transects surveyed in the barge load-out wharf and swing circle footprints.

The survey results for the transshipment mooring location in Mira Bay indicate the sediment is primarily silty sand (Figure 11, Appendix M). The water depths in the transshipment mooring location are approximately 24 m. This area contains low to no aquatic vegetation and generally low in species diversity. The dominant macrofauna observed was the purple sand dollar (Figure 12, Appendix M). Lobsters were not observed within the transshipment mooring location, though burrows in the sediment were noted, suggesting the possible presence of larger crustaceans (lobster or crab) or fish.

ROV (CBCL 2006) surveys were conducted in the general vicinity of the barge load-out facility and in Schooner Pond Cove. The substrate at both these locations contained boulder and kelp and appeared to provide good lobster habitat.

A more detailed description of the marine benthic habitat observations by Stantec is provided below.

Barge Load-out Facility

Transect A

Transect A was the longest transect of the study at 560 m and lay along the centerline of the proposed barge load-out wharf and breakwater footprint. Transect A started in the nearshore subtidal environment at a depth of approximately 6.6 m and ended at a depth of 7.8 m at the angle in the breakwater footprint. The substrate was predominantly cobble and rubble with areas of gravel towards the terminal end of the transect. It was not possible to characterize the substrate in the final 60 m of the transect because of the high densities (nearly 100 percent coverage) of macroflora such as rockweed (*Fucus* spp.) and dulse (*Palmaria palmata*). Irish moss (*Chrondrus crispus*) and sourweed (*Desmarestia spp.*) were observed attached to hard substrate throughout the transect in low densities (0 – 10 percent). The dominant macrofauna were green sea urchins (*Strongylocentrotus droebachiensis*), periwinkles (*Littorina spp.*) and palmate sponge (*Isodyctya palmata*). One Atlantic lobster (*Homarus americanus*) was observed in a cavity under a rock in approximately 6.7 m of water (Photo 5.7.4). The variance in substrate size creates a range of interstitial spaces which would provide habitat for numerous species such as crustaceans, echinoderms, molluscs and fish. In addition, the range of substrate sizes provide habitat for various life stages of these species. Figure 12, Appendix M illustrates the location of species observed during the benthic surveys within the barge load-out facility footprint.

Transect C1

Transect C1 started from the endpoint of Transect A and followed the breakwater footprint from northeast to southwest in approximately 7 m of water (Figure 1, Appendix M). The substrate along Transect C1 consisted of rubble and cobble and generally larger substrate than that observed along Transect A. Macroflora observed along C1 included brown and red algae with the presence of *Fucus* spp. and Irish moss confirmed in the analysis of the underwater video.

Macrofauna observed along this transect included palmate sponge, green sea urchins and periwinkles (Photo 5.7.5). The water depth was uniform along the 110 m transect.

Transect C2

Transect C2 ran parallel to Transect C1 along the approximate centerline of the breakwater footprint in about 7 m of water (Figure 1, Appendix M). The seafloor grade was uniform along this 150 m transect. The substrate along C2 consisted predominantly of cobble-sized rock with interspersed gravel and rubble. Macroflora observed along C2 included brown and red algae with the presence of rockweed and Irish moss. The macrofauna consisted of intermittently dispersed palmate sponge and green sea urchins along the transect.

Transect C3

Transect C3 ran parallel to Transect C2 along the southern boundary of the breakwater footprint in approximately 7 m of water (Figure 1, Appendix M). The substrate along C3 consisted predominantly of cobble-sized rock. The substrate was observed to increase in size nearing the terminal end of the transect. Macroflora coverage of the seafloor along C3 was low (2 – 5 percent) and included Irish moss. Encrusting calcareous algae were observed on the rock substrate. Macrofauna noted along this transect included interspersed palmate sponge and green sea urchins along the transect. The seafloor grade was uniform along the 150 m transect.

Photo 5.7.4 Atlantic lobster in a den with Irish moss cover at Transect A.

Photo 5.7.5 Typical rocky habitat within the proposed footprint for the barge load-out wharf with palmate sponge located 10 m along Transect C1

The transect surveys conducted within the barge load-out facility footprint covered an estimated 3,320 m^2 of benthic habitat. The predominant substrate type was cobble and rubble. Pockets of gravel and sand were observed in bands running parallel to the shoreline approximately 360 m from the shore. Table 5.7.8 lists the percentage of each substrate type observed within the benthic habitat surveyed for the barge load-out facility footprint.

Table 5.7.8 Substrate Composition in the Proposed Barge Load-out Facility Footprint

Substrate Type	Barge Load-out Facility Footprint (%)
Bedrock	n/o
Boulder	n/o
Rubble	19.2
Cobble	77.8
Gravel	2.2
Sand	0.8
Mud	n/o
n/o: none observed	

Barge Swing Circle (at Barge Load-out Facility)

Transect D

Transect D (Figure 1, Appendix M) was conducted from north to south in approximately 7 m of water and where the seafloor grade was consistently leveled along the 250 m transect. The substrate was composed of cobble and rubble throughout the majority of the transect with a band of gravel present near the terminal end of the transect. Algal coverage of the seafloor was initially high with *Fucus* spp., Irish moss and sourweed covering approximately 30 percent of the rocky substrate. The density of algae reduced to 5 percent coverage and included Irish moss, sourweed and brushy red weed (*Cytoclonium purpureum*). The only macrofauna confirmed during the video survey of transect D were periwinkles, urchins and palmate sponge.

Transect E

Transect E was surveyed from east to west in approximately 7 m of water. The substrate along this transect was a mixture of cobble, rubble and gravel. Macroflora along this transect consisted of brown and red algae. The brown algae observations included rockweed. (*Fucus serratus* positively identified) and sour weed, while red algae present along the transect included dulse, Irish moss and brushy red weed. Macrofauna were observed in low abundance along this transect and species observed included periwinkles and green sea urchins.

The transect surveys conducted within the barge swing circle covered an estimated 2,500 m^2 of benthic habitat. The predominant substrate type was cobble. Small amounts of rubble and pockets of gravel were observed at the southern and western extents of the barge swing circle. Table 5.7.9 lists the percentage of each substrate type observed within the benthic habitat surveyed for the barge swing circle.

Table 5.7.9 Substrate composition in the Barge Swing Circle

Substrate Type	Barge Swing Circle Location (%)
Bedrock	n/o
Boulder	n/o
Rubble	7.7
Cobble	88.6
Gravel	3.7
Sand	n/o
Mud	n/o

n/o: none observed

Transshipment Mooring Location

Transect F

Transect F was surveyed from north to south in approximately 24 m of water. The substrate was entirely composed of silty sand with little variation in slope (Photo 5.7.6). There were small sand ripples observed along a north to south direction. Multiple empty burrows where observed in the sand that may have been created by crustaceans, such as hermit crab, rock/Jonah crab or lobster. Species of macrofauna observed on the seafloor included: purple sand dollars (*Echinarachnius parma*), rock or Jonah crab (*Cancer* spp.), scallop (*plactopecten magellanicus*), longhorn sculpin (*Myoxocephalus octodeceminosus*), unidentified yellow sponge, unidentified sand shrimp, unidentified hermit crab, and unidentified clam. Photo 5.7.6 illustrates the location of species observed during the benthic surveys in the transshipment mooring location. One observation of sour weed was noted, as well as drifting blades of kelp (*Laminaria* sp.) and rockweed.

Photo 5.7.6 Typical sandy substrate within the transshipment mooring location with sea scallop and attached sponge along Transect F. Many purple sand dollars are shown in background.

Transect G

Transect G was surveyed in an east to west direction in approximately 24 m of water. The substrate was entirely composed of silty sand with little variation in slope. Multiple empty burrows where observed in the sand but which did not contain any macrofauna. Species of macrofauna observed included: purple sand dollars (Photo 5.7.7), unidentified sand shrimp and an identified seastar (*Asteroas* spp.). No vegetation was noted other than drifting blades of kelp and rockweed.

Photo 5.7.7 Typical sandy substrate with purple sand dollars along Transect F in the transshipment mooring location.

Benthic habitat surveys conducted in the transshipment location covered an estimated area of 2,500 m2. The substrate was composed of predominantly sand (Table 5.7.10). The loose, fine-grained substrate allowed sediment samples to be collected with a grab and which were then analyzed for potential contaminants and grain size. Small amounts of silt and clay were noted from the results of the grain size analysis. Table 5.7.10 lists the average percentage of each grain size obtained from the laboratory analysis of the samples collected at the transshipment mooring location.

Table 5.7.10 Substrate Composition in the Transshipment Mooring Location

Substrate Type	Transshipment Mooring Location (%)
Gravel	0.1
Sand	85.7
Silt	11.5
Clay	4.1

Sediment Chemistry

Sediment sampling with a Van Veen grab on December 15, 2011 was only possible at the transshipment mooring location because the substrate is predominantly fine silty sand (refer to Figure 11, Appendix M). The location of the three sampling stations is provided in Figure 1, Appendix M. The results for the physical and chemical analysis of these sediment samples are presented in Table 5.7.11. The chemical analysis results were compared against the guidelines issued by the Canadian Council of Ministers for the Environment (CCME) for both the Interim Sediment Quality Guidelines (ISQG) and the Probable Effects Levels (PEL). The ISQG are the most stringent of the two guidelines and represent concentrations of various contaminants which are expected to cause no effect to marine life. The PEL represent the concentrations of the same contaminants which were observed to cause effects to marine life in various studies.

Table 5.7.11 illustrates that the sediment does not exceeded either the CCME ISQG or PEL criteria for available guidelines. The grain size analysis of the sediment samples confirmed the transect surveys in the field that the sediment at the transshipment mooring location is predominantly silty sand (mean of 85 percent sand and 12 percent silt). Total organic carbon in the samples was relatively low (mean of 4.1 g/kg) at the transshipment location.

Table 5.7.11 Sediment Chemistry Results for Samples from the Transshipment Mooring Location

Analytical Parameter	Units	Reportable Detection Limit (RDL)	CCME Sediment Quality Guidelines[1]		Station		
			ISQG [2]	PEL [3]	1	2	3
Polycyclic Aromatic Hydrocarbons (PAH)							
1-Methylnapthalene	mg/kg	0.005	**ng**	**ng**	0.013	0.012	0.009
2-Methylnapthalene	mg/kg	0.005	**0.0202**	**0.201**	0.017	0.016	0.011
Acenaphthene	mg/kg	0.005	**0.00671**	**0.0889**	ND	ND	ND
Acenaphthylene	mg/kg	0.005	**0.00587**	**0.128**	ND	ND	ND
Anthracene	mg/kg	0.005	**0.0469**	**0.245**	ND	ND	ND
Benzo(a)anthracene	mg/kg	0.005	**0.0748**	**0.693**	ND	ND	ND
Benzo(a)pyrene	mg/kg	0.005	**0.0888**	**0.763**	ND	ND	ND
Benzo(b)fluoranthene	mg/kg	0.005	**ng**	**ng**	ND	ND	ND
Benzo(g.h.i)perylene	mg/kg	0.005	**ng**	**ng**	ND	ND	ND
Benzo(j)fluoranthene	mg/kg	0.005	**ng**	**ng**	ND	ND	ND
Benzo(k)fluoranthene	mg/kg	0.005	**ng**	**ng**	ND	ND	ND
Chrysene	mg/kg	0.005	**0.108**	**0.846**	0.008	0.007	ND
Dibenz(a.h)anthracene	mg/kg	0.005	**0.00622**	**0.135**	ND	ND	ND
Fluoranthene	mg/kg	0.005	**0.113**	**1.494**	0.011	0.009	ND
Fluorene	mg/kg	0.005	**0.0212**	**0.144**	ND	ND	ND
Indeno(1, 2, 3-cd)pyrene	mg/kg	0.005	**ng**	**ng**	ND	ND	ND
Naphthalene	mg/kg	0.005	**0.0346**	**0.391**	0.010	0.008	ND
Perylene	mg/kg	0.005	**ng**	**ng**	ND	ND	ND
Phenanthrene	mg/kg	0.005	**0.0867**	**0.544**	0.020	0.017	0.013
Pyrene	mg/kg	0.005	**0.153**	**1.398**	0.010	0.009	ND

Table 5.7.11 Sediment Chemistry Results for Samples from the Transshipment Mooring Location

Analytical Parameter	Units	Reportable Detection Limit (RDL)	CCME Sediment Quality Guidelines[1]		Station		
			ISQG [2]	PEL [3]	1	2	3
Total Polychlorinated Biphenyls (PCB)	mg/g	0.01	**0.0215**	**0.189**	ND	ND	ND
Total Petroleum Hydrocarbons (TPH)							
Benzene	mg/kg	0.03	**ng**	**ng**	ND	ND	ND
Toluene	mg/kg	0.03	**ng**	**ng**	0.05	ND	ND
Ethylbenzene	mg/kg	0.03	**ng**	**ng**	ND	ND	ND
Xylene (Total)	mg/kg	0.05	**ng**	**ng**	0.12	ND	ND
C6 - C10 (less BTEX)	mg/kg	3	**ng**	**ng**	ND	ND	ND
>C10-C16 Hydrocarbons	mg/kg	10	**ng**	**ng**	ND	ND	ND
>C16-C21 Hydrocarbons	mg/kg	10	**ng**	**ng**	ND	ND	ND
>C21-<C32 Hydrocarbons	mg/kg	15	**ng**	**ng**	21	ND	ND
Modified TPH (Tier1)	mg/kg	20	**ng**	**ng**	21	ND	ND
Hydrocarbon Resemblance	-	-	**ng**	**ng**	Lube	N/A	N/A
Total metals							
Aluminum	mg/kg	10	**ng**	**ng**	28000	29000	27000
Antimony	mg/kg	2	**ng**	**ng**	ND	ND	ND
Arsenic	mg/kg	2	**7.24**	**41.6**	4.9	4.1	4.4
Barium	mg/kg	5	**ng**	**ng**	200	230	200
Beryllium	mg/kg	2	**ng**	**ng**	ND	ND	ND
Cadmium	mg/kg	0.3	**0.7**	**4.2**	ND	ND	ND
Chromium	mg/kg	2	**52.3**	**160**	22	22	22
Chromium (VI)	mg/kg	0.002	**ng**	**ng**	ND	ND	ND
Cobalt	mg/kg	1	**ng**	**ng**	5.4	5.5	5.4
Copper	mg/kg	2	**18.7**	**108**	6.0	7.0	5.4
Iron	mg/kg	50	**ng**	**ng**	14000	15000	14000
Lead	mg/kg	0.5	**30.2**	**112**	8.9	8.8	8.3
Manganese	mg/kg	2	**ng**	**ng**	280	370	330
Mercury	mg/kg	0.1	**0.13**	**0.7**	ND	ND	ND
Molybdenum	mg/kg	2	**ng**	**ng**	ND	ND	ND
Nickel	mg/kg	2	**ng**	**ng**	11	12	11
Selenium	mg/kg	2	**ng**	**ng**	ND	ND	ND
Available Selenium	mg/kg	1	**ng**	**ng**	ND	ND	ND
Strontium	mg/kg	5	**ng**	**ng**	68	68	62
Thallium	mg/kg	0.1	**ng**	**ng**	0.26	0.24	0.24
Tin	mg/kg	2	**ng**	**ng**	ND	ND	ND
Uranium	mg/kg	0.1	**ng**	**ng**	0.91	0.94	0.92
Vanadium	mg/kg	2	**ng**	**ng**	37	36	36
Zinc	mg/kg	5	**124**	**271**	31	32	32
Particle Grain Size							
Gravel	%	0.1	**ng**	**ng**	ND	ND	0.2
Sand	%	0.1	**ng**	**ng**	83	91	81
Silt	%	0.1	**ng**	**ng**	13	5.4	16

Table 5.7.11 Sediment Chemistry Results for Samples from the Transshipment Mooring Location

Analytical Parameter	Units	Reportable Detection Limit (RDL)	CCME Sediment Quality Guidelines[1]		Station		
			ISQG [2]	PEL [3]	1	2	3
Clay	%	0.1	**ng**	**ng**	3.8	3.7	3.0
Total Organic Carbon	g/kg	0.2	**ng**	**ng**	5.1	3.9	3.2
Moisture Content	%	1	**ng**	**ng**	25	26	23

ND Analytical Value < RDL
ng No guideline available
[1] Canadian Sediment Quality Guidelines for the Protection of Marine Life, Canadian Council of Ministers of the Environment (CCME), 1999, updated 2002
[2] Interim Marine Sediment Quality Guidelines (CCME), below which there is a low likelihood of adverse biological effects
[3] Probable Effects Level (PEL), above which there is a strong likelihood of adverse biological effects
700 Result above the ISQG CCME guideline
3500 Result above the PEL CCME guideline

No sediment could be collected with a grab in the footprint of the barge load-out facility because of the substrate generally ranging in size from gravel to rubble as described previously. CBCL (2006) was able to collect sediment samples in the vicinity of this location and at Schooner Pond Cove. The analytical results for all three samples collected from the barge load-out area and the one sample collected from the western edge of Schooner Pond Cove met the CCME marine sediment guidelines. Trace detection of some hydrocarbons could be associated with either natural and/or anthropogenic sources (*e.g.*, vessel traffic). Long range transport of contaminants by predominant southeast currents is possible.

5.7.2.5 Algal Communities

Macroalgae, or seaweed, are large photosynthetic species that grow in the coastal waters of the marine environment that can be divided into different groups according to their colour and accessory pigments. The three main types of macroalgae are brown algae, green algae, and red algae. Algal seaweed species differ from their land relatives in that they do not have roots for gathering nutrients and instead absorb nutrients and minerals from the seawater that surrounds them. Algal species have strong holdfasts with which they attach themselves to rocks or hard surfaces. Their surrounding environment, sea water, keeps them buoyant to absorb adequate light for photosynthesis.

Seaweeds grow well on all rocky substrate, but grow most efficiently when they are in an exposed and clear water column (Aumack *et al.* 2007). Diversity is high when habitat consists of an open, rocky coast where salinity is high, summer air temperatures are moderate, and where the water temperature remains low. Warm summer temperatures and varying salinities found in estuaries and sheltered bodies of water can reduce diversity of macroalgae. Macroalgae experience seasonal growth, with growth halting in the cold winter months. In the coastal areas where freezing occurs, ice scour scrapes perennial seaweeds from the shoreline. The spring months bring new generations of annual and perennial plants to the rocky coastal zone.

The RAA has a diverse algal community dominated by <10 species (Schaefer *et al*. 2004). Air photos have been examined to estimate the proportion of algal coverage in the shallow proportion (<10 m) of algal beds in Sydney Bight. This method, although not the most accurate, yielded results from 8.4 percent coverage to 72 percent algal cover. It has been concluded that in general, areas that are <10 m with stable substrate will likely be covered in the absence of a sea urchin presence.

Seasonal ice cover, ice scouring, and low tidal amplitude (0.9 m) affect the marine plants in the RAA. These factors also play a role in creating a low intertidal zone, in which fast growing ephemerals and opportunistic species such as fucoids, *Chondrus crispus,* and small ephemeral brown algae dominate in waters less than 5 m in depth. Water depths between 4 m to 8 m are dominated by red algae, including *C. crispus*. The plant canopy in the RAA is low (<0.5 m) and lacks the dense beds of large laminarians that are common along other areas of the Atlantic coast of Nova Scotia (Schaefer *et al*. 2004). The lack of laminarians is thought to be from a combination of ice scour, friable substrate, sea urchin herbivory, and competition from red algae.

Within the PDA, the highest densities of macroalgae at the barge load-out facility were observed where the breakwater is angled and approximately 660 m from the shore. In general, the macroalgae increased in density with distance from shore, with higher densities associated with pockets of gravel in the southern and western extents. Figures 13 and 14, Appendix M illustrate the distribution of brown and red algal species, respectively, within the barge load-out facility footprint. *Fucus* spp. was the dominant brown algal species observed and at times covering up to 100 percent of the seafloor. Tables 5.7.12 and 5.7.13 list the composition of the macroflora community and the total seafloor area covered by macrophytes as a percentage of the total area surveyed for the barge load-out wharf footprint and the barge swing circle, respectively.

Table 5.7.12 Macroflora Composition at the Location of the Barge Load-out Wharf

Macrofloral species	Barge Load-out Wharf (%)
Irish Moss (*Chrondrus crispus*)	22.8
Fucus spp.	75.4
Sourweed (*Desmarestia* spp.)	1.7
Dulse (*palmaria palmata*)	0.1
Brushy Red Weed (*Cytoclonium purpuream*)	n/o
Wire Weed (*Ahnfeltia plicata*)	n/o
Total Macroflora Coverage of the Seafloor Surveyed (3,320 m^2)	**15.1**
n/o: none observed	

Table 5.7.13 Macroflora Composition at the Location of the Barge Swing Circle

Macrofloral Species	Barge Swing Circle Location (%)
Irish Moss (*Chrondrus crispus*)	15.5
Fucus spp.	74.7
Sourweed (*Desmarestia* spp.)	7.0
Dulse (*palmaria palmata*)	1.6

Table 5.7.13 Macroflora Composition at the Location of the Barge Swing Circle

Macrofloral Species	Barge Swing Circle Location (%)
Brushy Red Weed (*Cytoclonium purpuream*)	0.9
Wire Weed (*Ahnfeltia plicata*)	0.3
Total Macroflora Coverage of the Seafloor Surveyed (2,500 m^2)	**12.9**

Macrofloral abundance was minimal to non-existent at the transshipment mooring location (Table 5.7.14).

Table 5.7.14 Composition of Macroflora at the Transshipment Mooring Location

Macrofloral species	Transshipment Mooring Location (%)
Irish Moss (*Chrondrus crispus*)	n/o
Fucus spp.	n/o
Sourweed (*Desmarestia* spp.)	0.1
Dulse (*palmaria palmata*)	n/o
Brushy Red Weed (*Cytoclonium purpuream*)	n/o
Wire Weed (*Ahnfeltia plicata*)	n/o
Total Macroflora Coverage of the Seafloor Surveyed (2,500 m^2)	**0.1**
n/o: none observed	

5.7.2.6 Eelgrass and Salt Marsh Communities

A vascular species of the aquatic macrophyte, eelgrass (*Zostera marina*) is of ecological importance as beds of eelgrass support a high biodiversity of species, provide refuge for small species of fish, is a food source for migrating and overwintering waterfowl, and play a role in the global climate and ocean cycles. As such, eelgrass is also protected by law, under the *Fisheries Act*, based on its high value for fisheries species. Eelgrass and other seagrass populations worldwide are indicator species (*i.e.*, loss of seagrass is indicative of anthropogenic stress) (DFO 2009b).

Compared to other areas of Nova Scotia, the RAA is not known for its salt marshes. However, there are tidal marshes scattered throughout the sheltered bays and estuaries along the coast from Bay St. Lawrence to Scatarie Island (Schaefer *et al*. 2004). The most extensive and prevalent salt marshes are found in Aspy Bay, Spanish Bay, Lingan Bay, Glace Bay and Morien Bay. In many of these areas, eelgrass beds are found in the lower intertidal and subtidal zones adjacent to the salt marshes. Eelgrass beds are located in the sheltered bays and inlets along the coast between St. Anns Bay and Mira Bay. The most extensive areas of eelgrass are located in St. Anns Bay and Little Bras d'Or River, and behind barrier beaches in Lingan, Glace Bay and Morien Bay. Eelgrass and salt marsh communities are not present in the PDA or the LAA.

5.7.2.7 Fish

The marine waters surrounding the Donkin Peninsula contain the pelagic and demersal fish species that are common to the nearshore waters of coastal Nova Scotia and their food sources (CBCL 2008). Some species migrate in and out of the area seasonally, using the RAA to spawn, overwinter, or as a nursery. Other species simply pass through on their way to the Gulf of St. Lawrence, the Bras d'Or Lakes, and the rivers and streams that run into the RAA. There are some species which are restricted to the shallower waters including the shorthorn sculpin (*Myoxocephalus corpius*), immature white hake (*Urophycis tenuis*), white flounder (*Pseudopleuronectes americanus*), and immature cod (*Gadus morhua*). The coastal waters of the RAA are known as important overwintering areas for populations of cod, white hake, American place, witch flounder, red fish and herring. There are multiple anadromous or catadromous fish species found in the rivers and estuaries of the RAA including American eel, Atlantic salmon and striped bass. The RAA provides habitat for several commercial fishery species that are discussed further below.

5.7.2.7.1 Plankton

Plankton are the very small (often microscopic), free-floating organisms that live suspended in the water column. Physical processes, such as water currents and turbulent mixing, often control the distribution of plankton. Plankton are an integral part of the ocean food chain; phytoplankton (often unicellular algae) are eaten by zooplankton, which are, in turn, eaten by larger organisms. Plankton are therefore a major factor in influencing the biodiversity and productivity of marine habitats. Recognizable areas of enhanced plankton production may therefore suggest potentially important areas for fish, marine mammals and sea turtles.

Phytoplankton

Information on phytoplankton in the RAA is limited. In general with regards to phytoplankton in Atlantic Canada, coastal waters are more productive than the open ocean. In coastal waters primary production (carbon content of living organisms) is estimated at 1000 kg organic carbon/ha/y, while the estimated primary production in the open ocean is half of that at 500 kg organic carbon/ha/y (Schaefer *et al*. 2004). A spring bloom of phytoplankton occurs in the Cabot Strait from February to May, with a fall bloom occurring from August to November. The spring bloom is the most significant growth period with chlorophyll concentrations reaching 12.3 mg/m^3 to 16 mg/m^3 *in situ* (Schaefer *et al*. 2004). The waters surrounding the Donkin Peninsula are characterized by significant upwelling (Gromack *et al*. 2010). Upwelling brings nutrients from greater depths, which in many cases is a limited factor in phytoplankton growth. As a result, the waters surrounding the Donkin Peninsula have the potential for high primary production.

Zooplankton

Zooplankton are animals ranging in size from <1 mm, such as copepods, to approximately 4 cm (*e.g.*, krill). Zooplankton are consumers and depend on phytoplankton for the bulk of their food

(Schaefer *et al*. 2004). Eggs and larvae of larger animals, such as fish and crustaceans, are also included in the diet of larger zooplankton. In turn, many organisms in higher trophic levels, such as fish and marine mammals, include zooplankton in their diet. Thus, zooplankton plays a very important role in marine food webs.

The Nova Scotia Current has a strong influence on zooplankton in the Sydney Bight area, resulting in a more oceanic community than those found in western Cape Breton in the Southern Gulf of St. Lawrence (Schaefer *et al*. 2004). Significant concentrations of copepods have been found in the area, with *Calanus* spp. counts of approximately tens of thousands/m^2. The northeastern Scotian Shelf has higher concentrations of the copepods *Calanus glacialis*, *C.hyperboreus, C. finmarchicus,* and *Temora* sp., than the southwestern half (Locke 2002).

One of the major sources of information on zooplankton for Eastern Nova Scotia is the Scotian Shelf Ichthyoplankton Program (SSIP), which was conducted from 1976-1982. The copepod community in Eastern Nova Scotia is very diverse with high abundances of *Calanus finmarchicus*, *Pseudocalanus minutus, Centropages typicus* and *Scolecithricella minor.* Other species present at this time were *Acartia longiremis, Calanus glacialis, Calanus hyperboreus, Candacia pachydactyla, Centropages bradyi, Clausocalanus furcatus, Clytemnestra rostrata, Corycaeus speciosus, Paraeuchaeta* (as *Euchaeta*) *norvegica, Paraeuchaeta* (as *Euchaeta*) *tonsa, Gaetanus* sp., *Lucicutia flavicornis, Macrosetella gracilis, Metridia longa, Metridia lucens, Microcalanus pygmaeus, Oithona atlantica, Oithona similis, Oncaea media, Paracalanus parvus, Pleuromamma borealis, Pleuromamma robusta, Scolecithrix danae, Temora longicornis, Temora stylifera, Undinula vulgaris* and unidentified harpacticoids (Locke 2002).

Ichthyoplankton

Ichthyoplankton are part of the zooplankton population that are specific to fish larvae and eggs and at times, have been known to include the larvae and eggs of important shellfish species as well. Ichthyoplankton, along with other planktonic early life stages of marine animals, are collectively referred to as the meroplankton.

The Sydney Bight area region is an important area for the early life history stages for many commercially important crab species. Based on the SSIP surveys, five larval crab species have been identified in the area including: snow crab, Jonah crab, Rock crab, Atlantic lyre crab, and Arctic lyre crab (Locke 2002). The region is primarily important for the earliest larval life stages. Rock crabs are the most abundant larval crabs in the Sydney Bight area with numbers exceeding 1000 larvae/1000m^3. Jonah crab larvae were also found to be abundant within the area. Sampling for the invasive green crab larvae has not been conducted but it is assumed that based on the adult populations in the RAA they are present in the area (Tremblay *et al*. 2006); as one of the dispersal mechanisms of this species is advection of the planktonic stages in coastal currents.

The distribution of lobster larvae is not known in the RAA and in general little is known about the larval distribution along the South and Eastern Shores of Nova Scotia and Cape Breton; it is believed that the larvae are likely retained in local areas (DFO 2011c). Larval plankton tows from late August to September 2011 in False Bay and approximately 5 km south from the transshipment location revealed the presence of lobster larvae until mid-September with a relative higher abundance in late August compared to September (www.lfa27.com/2011-science-programme-for-lfa27/larval-tows). During the SSIP it was found that lobster larvae occur earlier in Sydney Bight than elsewhere on the Scotian Shelf, with larvae occurring from late June through to mid-September.

Northern shrimp larvae are present in the area from mid-February to the end of June. Sea scallop larvae are present from August to November. Sea urchin larvae are also present from April to June.

5.7.2.7.2 Shellfish

Shellfish are known to inhabit the RAA based on the 1993-2000 catch data available for NAFO Subdivision 4Vn. The RAA is a productive area for invertebrates with some species being fished commercially (Zwanenburg *et al*., 2002). Lobster and snow crab are the most economically important species in the RAA. Rock crab is a developing fishery in the area, while scallops, mussels, and oysters are harvested periodically on a small scale (Schaefer *et al*. 2004). There has been an increase in snow crab and urchin fisheries in recent years, with sea urchins, rock crab, scallops, and snow crab making up 36 percent, 35 percent, 12 percent, and 6 percent of the total catch respectively (Gromack *et al*. 2010). Toad crab, stone crab, sea urchins and shrimp are of a commercial interest in the area, but have yet to be proven in the RAA. Additional information on the landings and value of commercial shellfish species is provided in Section 5.8.

American Lobster

American lobsters are distributed in localized populations in nearshore areas around the coast of Cape Breton. The spring fishing season removes adult individuals from the population prior to moulting and spawning. Adult female moulting and spawning occurs during one summer, whereas the second summer is dedicated to laying the eggs. Young females will moult, spawn and lay in the same summer (DFO 2003).

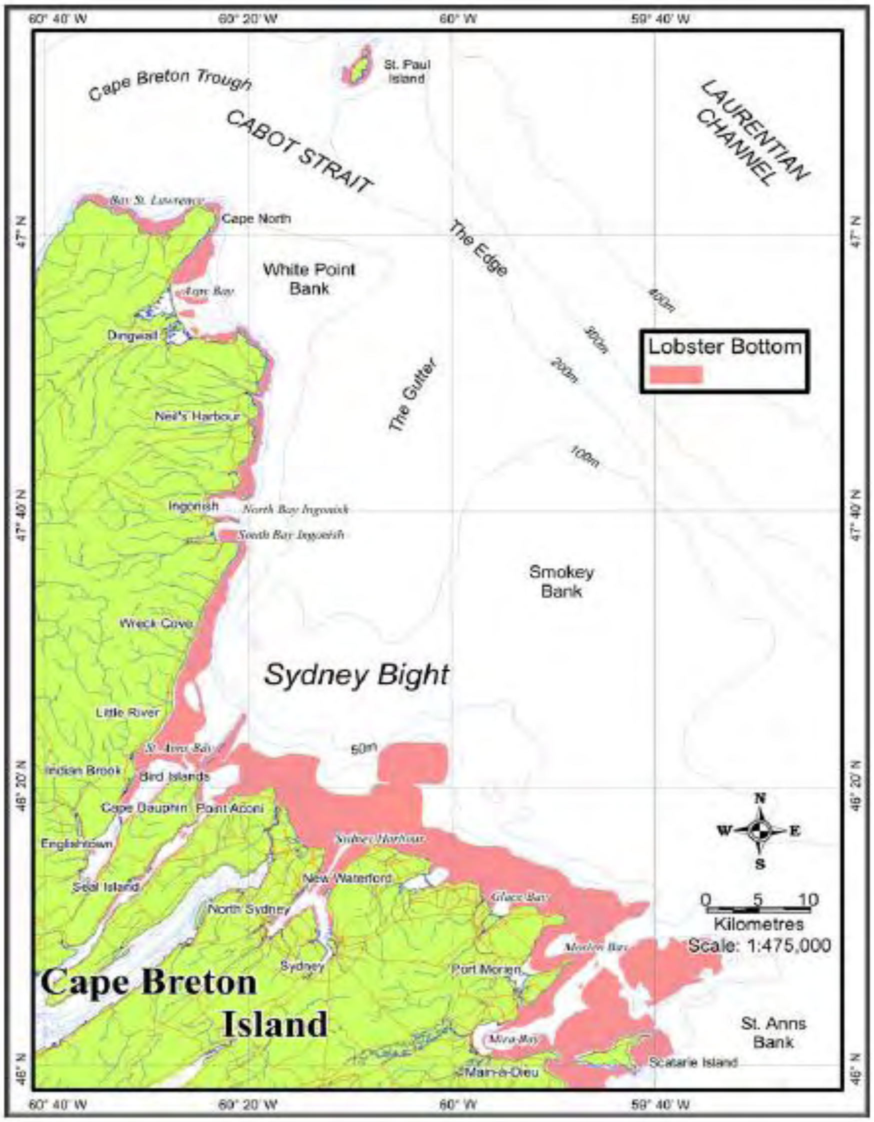
Courtship generally occurs before moulting for adult females. Immediately after moulting (when the female’s carapace is still soft), the female will mate with a male and store the male’s spermatophore within a receptacle under the female’s abdomen until she spawns the following year. The eggs are extruded during the summer and autumn months and may number in the thousand to tens of thousands. Even with the large number of eggs released the survival rate is low, and about one in ten fertilized eggs will grow to become adults (DFO 2009c).

Once spawning has occurred, eggs are brooded for a year under the female’s abdomen; hatching and larval release occurs and the post-larval lobsters live for 6 to 10 weeks in the water column in a planktonic phase, where they moult and pass through three larval stages before settling on the seafloor. Within the first three larval stages, the planktonic larvae spend most of the time in the upper 1 m of the water column. The feathery hairs on the legs provide mobility and along with currents, this aids the larvae locating appropriate habitat for growth and development (DFO 2003).

The fourth larval stage is where the lobster begins the search for specific habitats. The post-larval lobster will move up and down in the water column, bobbing along in search of habitats. The preference for habitats seems to be for hard bottom with many interstitial spaces (*e.g.*, cobble or larger rock). As the lobster settles into its new habitat, it moults into the fifth stage. The first year of benthic life is spent mostly hiding from enemies in tunnels or crevices in between rocks (Gulf of Maine Research Institute 2008).

The natural diets of immature lobsters remain similar to their mature counterparts. In Newfoundland, the most frequent prey found in a study of lobster stomach contents included green sea urchins, mussels, rock crab, polychaetes and brittle stars (DFO 2009c). Known areas of lobster habitat in the vicinity of the RAA is provided in Figure 5.7.7.

Figure 5.7.7 Known Area of Lobster Habitat in Sydney Bight



Schaefer *et al.* 2004.

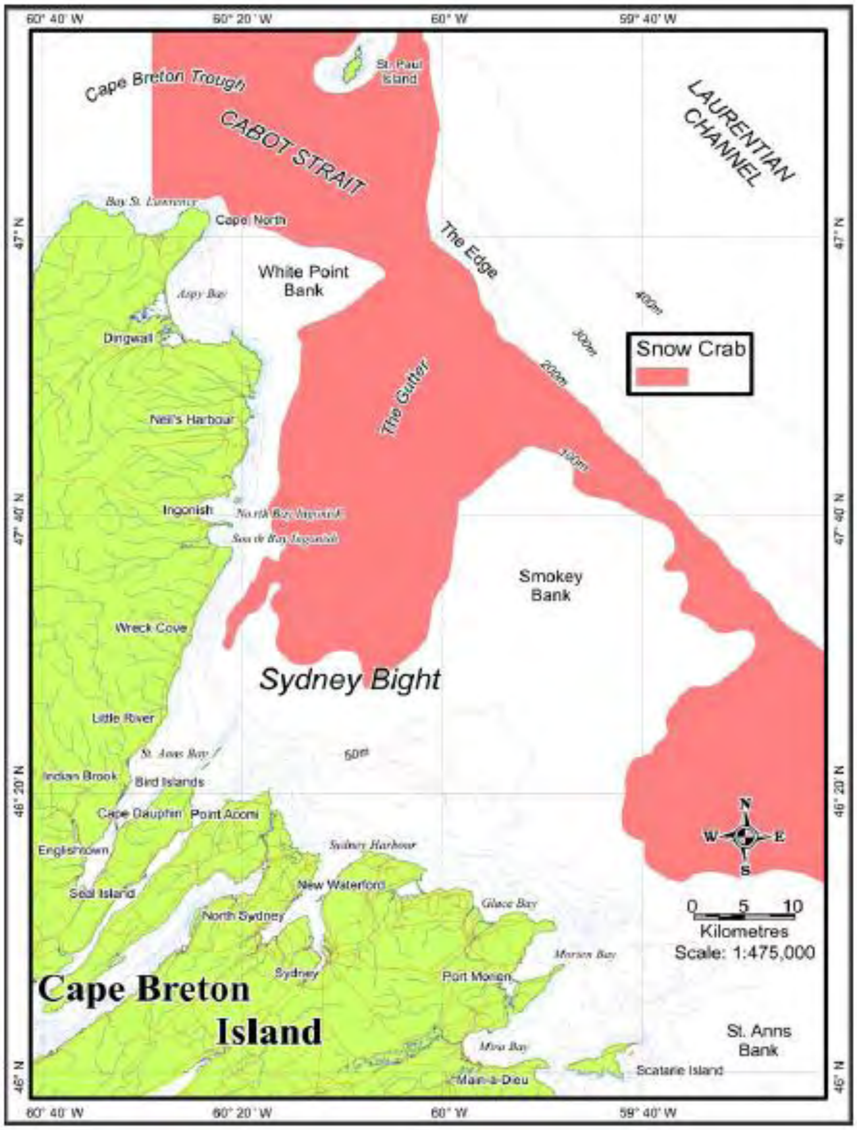
Snow Crab

Snow crab (*Chionoecetes opilio*) is a decapod crustacean that occurs over a broad depth range (50 to 1,300 m) in the northwest Atlantic. Snow crabs have a tendency to prefer water temperatures ranging between -1.0°C and 4.0°C. Snow crabs generally move to shallower waters to mate, with the increase in temperature speeding up embryonic development. Fertilization occurs internally for snow crabs and mating occurs once the female has moulted. The fertilized eggs are extruded within 24 hours and are attached to the female's pleopods. The number of eggs released by the female in one clutch can number up to 128,000 (DFO 2010d). Subsequent clutches of eggs can be fertilized by spermatophores stored ventrally. The eggs are incubated up to 27 months, with embryonic development occurring more quickly in warmer waters (DFO 2010e). Hatching occurs during early spring (April to June), where the larvae, known as zoea, spend 12 to 20 weeks as zooplankton feeding on microzooplankton in the water column (DFO 2010d). There are a total of three larval stages before the snow crabs settle to the bottom.

Males continue to moult into adulthood and only a portion will recruit into the fishery, which defines a minimum carapace width of 95 mm. It takes on average eight years for snow crab to be large enough to be retained by the fishery (DFO 2010f). Commercial-size snow crab can be found on a variety of substrates but are most common on mud or mud/sand bottoms, while smaller crabs are found within the interstitial spaces of harder substrates. Adult snow crab typically feed on fish, clams, polychaete worms, brittle stars, shrimp and crustaceans, including smaller snow crab (DFO 2009d).

Known areas of Snow crab habitat in the vicinity of the RAA are illustrated in Figure 5.7.8.

Figure 5.7.8 Known Area of Snow Crab Habitat in Sydney Bight



Schaefer *et al*. 2004.

Rock Crab

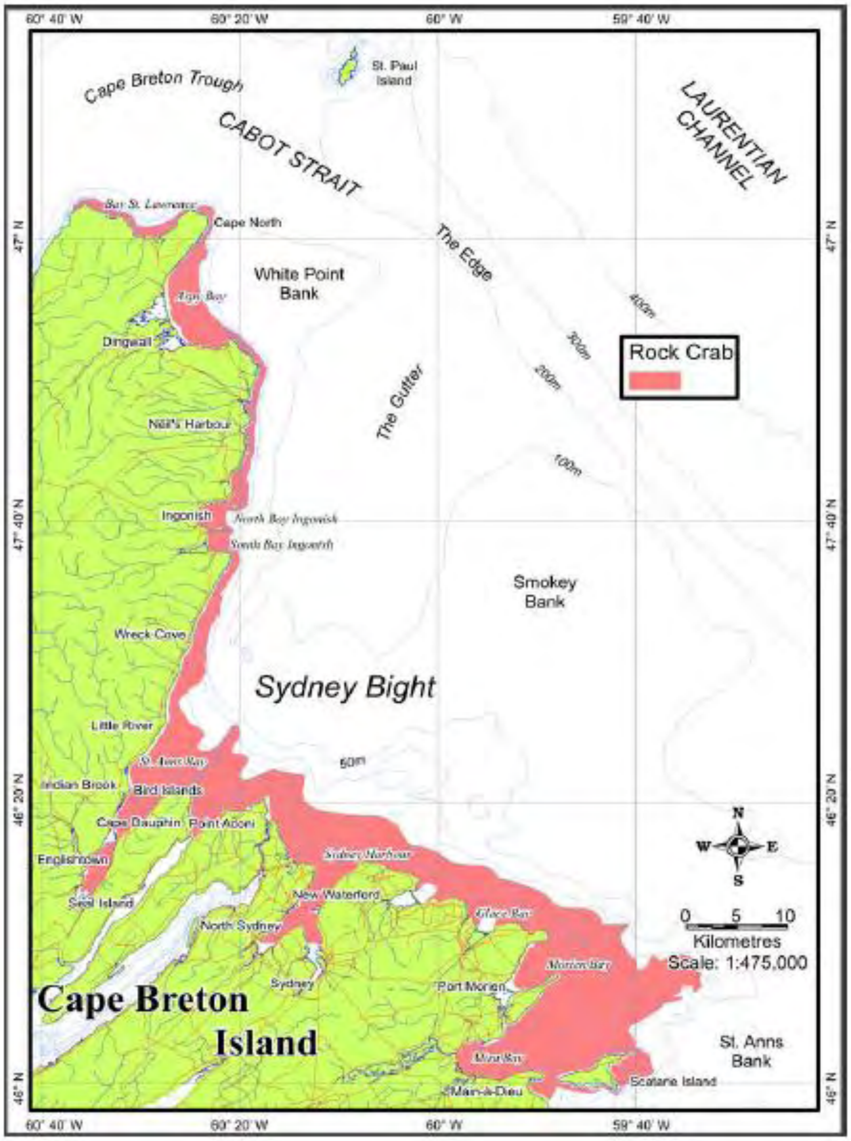
Rock crabs are decapod crustaceans that congregate in waters typically less than 20 m deep and prefer rocky substrate to sandy bottom habitat. Preference is given to those habitat areas with macroalgal growth on the rocky substrate (DFO 2010f).

Sexual maturity is generally attained with three to six years of age, with carapace widths of 25 and 40 mm for females and males, respectively. Moulting typically occurs primarily in April and May, with mating occurring while the female is in a soft-shelled state. The fertilized eggs are generally extruded in late October and the eggs are stored under their abdomen for up to a year (DFO 2000a). Larval hatching occurs in the late spring/summer months, with the free-swimming larvae aggregating near the surface. The larvae moult through six stages (five zoeas and one megalopa) before settling to the seafloor (DFO 2010f). These six stages of planktonic larvae can take up to three months before becoming a benthic crab (DFO 2000a). Throughout these stages the larvae are omnivorous planktivores.

Adult rock crabs are one of the major predators in northern subtidal communities. Their diet includes juvenile scallops, mussels, snails, green sea urchins, seastars, amphipods, sand shrimp and polychaetes. Large rock crabs are known to take young lobsters. Adult rock crabs will reach commercial size at six years of age (DFO 2010f).

Known areas of Rock crab bottom habitat in the vicinity of the RAA can be seen in Figure 5.7.9.

Figure 5.7.9 Known Rock Crab Habitat in Sydney Bight



Schaefer *et al*. 2004.

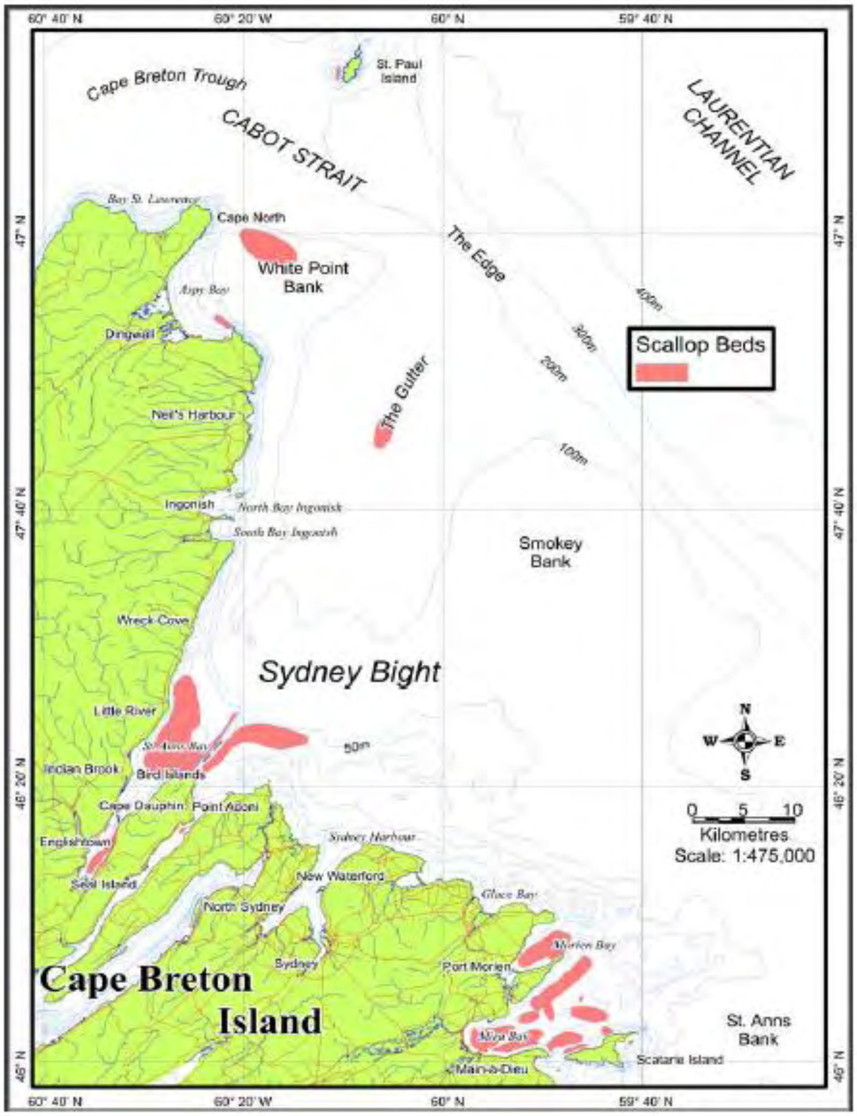
Atlantic Sea Scallop

The Atlantic sea scallop is a bivalve mollusc that lives in communal beds on the seafloor and is found from North Carolina to Newfoundland. It occurs on the Atlantic Continental Shelf and typically occurs in relatively shallow water (<100 m depth). In the Gulf, sea scallop are found at water depths of 10 to 25 m. Scallop occur in groups or beds that may be sporadic or last for numerous years. These beds correspond to areas of suitable temperature, food availability and substrate. Adult scallop are typically located on clean bottom such as gravel and where gyres occur, keeping larval stages in the vicinity of the spawning population (Stewart and Arnold 1994). The distribution of scallop beds in the vicinity of the RAA is provided in Figure 5.7.10.

Sexual differentiation occurs at age 1, with sexual maturity reached at age 2, although mature scallop do not contribute substantially to reproduction until age 3. Spawning occurs in early fall (August to October), prompted by water temp decreases. Within the western coast of Newfoundland, a second spawning season occurs between the months of June and July (Stewart and Arnold 1994).

Males and females release gametes synchronously and fertilization is external in the water column. Eggs develop in one to two days into the first of three larval stages, which all together will last five weeks. In the first larval stage, the sea scallops are planktonic but can swim freely and have been shown to undergo daily vertical migration (DFO 1996). During the planktonic stage, a shell, eye spot and foot develop. Scallop larvae are omnivorous planktonic feeders. The sea scallop larvae then settle to the bottom and develop the remainder of features. Planktonic larvae usually settle on suitable substrates such as sand to begin their benthic life (DFO 1996). Newly settled larvae attach to suitable substrate by secreting threads, which aid against movement from bottom currents. As young scallop age, they become less mobile and show less of a tendency to attach to the bottom. Adult sea scallop are filter feeders that use gills to capture phytoplankton and other suspended particulate material from the water.

Figure 5.7.10 Known Atlantic Sea Scallop Bottom Habitat in Sydney Bight



Schaefer *et al*. 2004

Mussel

The blue mussel is the most commonly landed and farmed mussel on the East Coast of North America. The mussel is a bivalve mollusc, spending their entire life cycle attached to hard surfaces filter feeding from the marine environment which surrounds them. It has a triangular shape and many fine concentric lines on the surface of its shell (Rodger 2006). The outer shell is blue to black in colour with a shiny covering (periostacum), with the inside of the shell being a white colour with purplish margins. The life cycle of the mussel begins in the spring when the adult mussel produces larvae which attach themselves to hard surfaces such as stones, pebbles, pilings, and wharves. After attachment the larvae become permanently stationary for the remainder of their lives. The mussels then feed on phytoplankton which they filter out of the surrounding waters.

Oyster

The oyster is a bivalve mollusc spending their entire life cycle attached to a hard substrate. The most common oyster found in the waters in the Sydney Bight area are the Eastern oyster. The Eastern oyster is a bivalve with two shells or valves (Rodger 2006). The top valve is relatively flat acting as a lid, while the bottom is cupped to hold seawater. Both valves are usually a mixture of brown, green, grey, and white, with a rough sculpted appearance and an oval or teardrop shape. The gender of the oyster may actually change several times over the course of its lifespan which can be up to 100 years. Reproduction begins when the gonad organ produces eggs and sperm which are released over the course of a 4-6 week period, typically in the summer when the water temperatures reaches 15.5°C or higher. The eggs are fertilized in the water column and drift for a few weeks before settling on the bottom. Oyster larvae are consumed as plankton by many marine organisms and roughly 1 percent of all larvae reach the benthic surface to metamorphose into a small oyster known as ‘spat’.

Sea Urchin

Sea urchins are found in shallow rocky bottom subtidal areas all along the coast of eastern Cape Breton (Schaefer *et al*. 2004). During a 1984-1985 survey it was found that urchins are most prevalent in exposed areas at depths between 5-10 m.

Urchins are usually found in high concentrations in feeding fronts bordering the deep edge of kelp beds (Schaefer *et al*. 2004). No urchin-kelp cycle has been documented in the Sydney Bight area; however, detailed information is lacking to confirm this. An urchin roe fishery has developed off Nova Scotia in recent years, but it is not well developed in Sydney Bight. Urchin spawning in Sydney Bight likely occurs from March to April, and larvae are planktonic for several weeks. Larval settlement likely occurs between June and July.

Northern Shrimp

Northern shrimp inhabit cold waters (<6°C) with muddy bottoms high in organic content. Commercial fishing efforts at the edge of the Laurentian Channel and a shrimp trap fishery in Sydney Bight have yielded low catch rates. Shrimp are immobile and potentially vulnerable to predators over the few days when moulting occurs (Tremblay *et al*. 2001).

Other Commercial Species

There is limited information about other crab species with potential for commercial exploitation. There have been intermittent exploratory fisheries for toad crab in the RAA, but these fisheries met with limited success (Tremblay *et al*. 2001). Toad crab is fished at depths between 35 and 80 m and the moulting period in the RAA likely occurs between June and September; however, the peak moulting time is unknown. Little is known about the timing of life history events or seasonal or annual movements for toad crab (Tremblay *et al*. 2001).

5.7.2.7.3 Bony Fish

DFO conducts two trawl surveys throughout Sydney Bight. The Summer Research Vessel Trawl has been conducted since 1970 and is restricted to deeper waters during the summer months (Schaefer *et al*. 2004). The 4Vn inshore survey was added to sample inshore areas in and adjacent to the RAA, and has been conducted since 1991 to sample fish and invertebrates less than 37 km (20 nautical miles) offshore. The Summer RV Trawl has indicated that at least 88 species of finfish inhabit 4Vn, with less than 20 of those species being commercially exploited. The most common species caught were Atlantic cod, Atlantic herring, American plaice, capelin, redfish, and white hake. Data suggest that some fish are widespread, while others are restricted to specific areas. In general, larger fish are found at deeper depths, while younger juvenile fish can be found in shallower waters (Schaefer *et al*. 2004). There are some limitations to the inshore survey as it is restricted to gravel sand or mud substrates because the trawl gear is not suited for hard bottoms. Also the data were collected during the summer season only, which does not give the full picture on species structures.

Demersal Fish

Atlantic Halibut

A cold-water demersal flatfish, the Atlantic halibut can be found in waters on both sides of the North Atlantic and into parts of the Arctic. Atlantic halibut spawn annually between winter and spring (February to April), synchronous within a group. Females are batch spawners able to ovulate several batches of eggs during one winter. Spawning is believed to occur at depths of up to 183 m on the slopes of the Continental Shelf (Scott and Scott 1988). Atlantic halibut eggs are some of the largest in the fish community, measuring up to 4 mm. Once fertilized, the eggs are deposited into the water column and free-float at depths ranging from 54 to 200 m (Scott and Scott 1988). The eggs are neutrally buoyant in salinities ranging from 35 to 37 ppt, meaning the Atlantic halibut eggs would sink towards the seafloor. Incubation of the eggs lasts for up to 20 days. Upon hatching into a larval state, the larvae are 6 to 7 mm long and have no pigment, functional eyes, or mouth. Little is known on the larval stage of the Atlantic halibut but it is thought that the larvae remain close to the water surface. The larvae survive on a relatively large yolk sac, which is completely absorbed after 50 days. Eye migration begins approximately at day 80 (Scott and Scott 1988). Juveniles are known to inhabit distinct nursery grounds for three to four years before migration to spawning habitat (DFO 2006). Sexual dimorphism is present within adult of the species, with females substantially larger than males. Adult populations feed on fish, mollusks and crustaceans, with a similar diet in the juvenile stages. Atlantic halibut catches from the 2009 summer RV Survey are provided in Appendix M.

Haddock

Haddock is a demersal species that is distributed from Greenland to the eastern mid-Atlantic. Haddock spawn over pebble and gravel substrate (avoiding rocks, kelp and soft mud) between March and April. The eggs are spawned on the seafloor but become buoyant after fertilization and rise in the water column (Cargnelli *et al*. 1999). Hatching occurs 9 to 32 days after spawning. Larvae metamorphose into juveniles in 30 to 42 days, with an average length of 2 to 3 cm. The juveniles inhabit the upper water column where they are opportunistic feeders on zooplankton. After three to five months, the juveniles migrate to the seafloor, where they begin their demersal life (Cargnelli *et al*. 1999). Early juveniles feed on less motile prey such as invertebrate eggs, copepods and phytoplankton. Adults tend to feed more on polychaetes and ophiuroids, but haddock are mostly opportunistic and will feed on crustaceans, polychaetes, mollusks and echinoderms. Adults are strongly associated with hard substrate seafloors of pebble and gravel and found in water depths from 40 to 150 m (Cargnelli *et al*. 1999). Catches of haddock from the Summer 2010 RV Survey are presented in Appendix M.

Greenland Halibut (Greenland Turbot)

Greenland halibut, also fished under the name Greenland turbot, is a cold-water, demersal flatfish species. Greenland halibut is described as having an amphiboreal distribution, meaning it is found in both the Atlantic and Pacific oceans. In the Atlantic Ocean, Greenland halibut can be located from Davis Strait through Newfoundland to as far south as the Gulf of Maine. Greenland halibut are widely distributed through the Gulf. In summer, the main populations are found in the St. Lawrence Estuary, the areas west and northeast of Anticosti Island, and near the west coast of Newfoundland in the Esquiman Channel.

Spawning generally occurs in the winter (November to February) within the Cabot Strait and can occur in depths of up to 1,000 m (DFO 2000b). Eggs are fertilized externally and float low within the water column. Eggs incubate for up to 12 weeks until metamorphosis into the larval stage. Early larval stages are also buoyant and found within the water column. Once the yolk sac has been absorbed, the larvae have been observed to rise in the water column. This is thought to correspond with the onset of feeding. Larval development lasts for up to 15 weeks and results in larval drift and dispersal from spawning areas (Chiperzak *et al*. 1995). In August or September and nearly one year post-spawning, the larvae settle to the seafloor, at which time the left eye has migrated to the right side of the fish. Unlike most flatfish, the migrating eye stops at the dorsal margin of the head (Alton *et al*. 1988). Adults reach maturity sooner in the Gulf (on average in 7.8 years). Adults generally feed on small crustaceans, demersal fishes (particularly redfish) and squid.

Monkfish

Monkfish, sometimes known as goosefish, is a large demersal fish from the family Lophiidae. The large, bulky head and enormous mouth characterize this species. Monkfish are distributed throughout the Western Atlantic Ocean from Florida to Labrador (NLDFA undated). The Gulf provides habitat for an abundant population within the warmer shelf waters. The monkfish prefer waters of between 6°C and 10°C (DFO 2000b) and research has shown that the monkfish will migrate to shallower water in summer and into deeper water throughout the winter (DFO 2000b). Monkfish can inhabit depths ranging from subtidal to 650 m. Spawning generally occurs in the fall (June to September), with the eggs deposited on the seafloor within large mucus sheets. Once fertilized, the eggs hatch in approximately seven days into larvae complete with pelvic fins and dorsal head spines (DFO 2000b). The larvae are pelagic for the first several months as opportunistic planktonic feeders prior to starting their demersal lives. Sexual maturity is reached between four and seven years. Adults consume a variety of marine organisms but are mainly piscivorous, with prey that includes herring, sand lance, alewife (*Alosa pseudoharengus*), smelt, cod, mackerel, striped bass, sculpin, sea raven, flounder, skate, crab, shrimp, starfish and marine worms (DFO 2000b).

Thorny Skate

The distribution range of the thorny skate extends from Greenland to South Carolina. Thorny skate occur at depths ranging from 20 to greater than 150 m and at temperatures ranging from -1.4°C to 6.0°C. The distribution of Thorny skate in Nova Scotian waters can be seen in Appendix M. In recent years, skate have been concentrating along the southwest slope and edges of the Grand Banks and it is estimated that approximately 80 percent of the biomass reside in this region (Kulka *et al*. 2004b). The greatest decline in thorny skate abundance has occurred in the northern extent of its range

Thorny skate rarely move more than 100 km and is considered a sedentary species. However, there are indications of seasonal migration from the plateau of the Grand Banks in winter to the edge and slope, returning in early summer (Kulka *et al*. 2004b). Egg cases are released in the fall and winter and hatching occurs approximately six months later. Young skates emerge from the egg case as free-swimming fish. They feed on polychaetes, crabs, whelks, sculpins, redfish, sand lance and haddock, with fish being more important prey items for larger skate (Scott and Scott 1988).

White Hake

White hake are a demersal species occurring from the Middle Atlantic Bight to the Gulf. White hake spawn in the summer (June to September) (DFO 2009e). Spawning occurs in open water, with the fertilized eggs remaining near the surface. Eggs hatch in three to seven days, with larvae remaining in the water column to feed. Juveniles migrate toward coastal habitats and can often be found within beds of eelgrass, feeding on shrimps and polychaetes. Sexual maturity is reached between two and five years. Food sources for adults include shrimp, krill and some fish. It is believed that the long pelvic fins are used to feel prey in the soft sediments that the white hake often inhabit as adults (DFO 2009e). The distribution of white hake during the Summer RV Surveys from 1993 - 2000 are provided in Appendix M.

Witch Flounder

Witch flounder, also known as greysole, is a demersal flatfish found in deep waters of the North Atlantic from lower Labrador to Cape Hatteras, North Carolina. Witch flounder aggregate in deep channel waters like those found in the Laurentian Channel, just southwest of St. Georges Bay, from January to February prior to spawning. Spawning occurs from spring to late summer (DFO 2009f). The fertilized eggs float and hatch after several days (Cargnelli *et al*. 1999). The larvae undergo a pelagic existence for up to a year, feeding on plankton before the juveniles settle to the bottom to begin their demersal life. In the Gulf, witch flounder move to deep water during the winter, where feeding can cease.

Witch flounder can be found in waters up to 1,569 m off the coast of Nova Scotia, although the highest abundance is caught within 185 to 400 m (DFO 2009f). Witch flounder are sedentary and appear to undertake very minimal migrations, with the populations aggregating in spawning habitats (Cargnelli *et al*. 1999). The small head and mouth of the witch flounder restricts the size of prey available for consumption. Main prey includes marine worms, small crustaceans, or shellfish (Cargnelli *et al*. 1999). The catch of witch flounder caught during the 2010 Summer RV Survey are provided in Appendix M.

Yellowtail Flounder

Yellowtail flounder is a demersal flatfish found in the waters from Chesapeake Bay to Labrador. Yellowtail flounder are prevalent around the Magdalen Islands and within the coastal waters of New Brunswick, Prince Edward Island and Nova Scotia within the Northumberland Strait (DFO 2009g). Spawning occurs on or near the seafloor in spring to early summer (May to July). The fertilized eggs float to the surface and drift during development. Hatching of the eggs occurs approximately five days after fertilization (DFO 2009g). The larvae remain in a pelagic state for a short time before drifting downward. Yellowtail flounder mature after three to five years and tend to inhabit waters less than 100 m deep where the bottom is composed of sand-mud sediments. Yellowtail flounder have recently been discovered to move off the bottom and, using mid-water tidal currents, displace from one area to another, although no clear migration patterns have been discovered. Adults tend to feed on crustaceans, polychaete worms and amphipods (DFO 2009g). The summer 2010 RV survey catches of yellowtail flounder are provided in Appendix M.

American Plaice

American plaice are very common and widespread throughout Sydney Bight, with higher abundances at depths below 50m (Schaefer *et al*. 2004). American plaice feed heavily in the summer months and cease to eat during the winter to early spring. As a result, the summer feeding months are important as they provide an energy store for metabolism and gonad development during the winter and early spring. American plaice 30 cm or less typically have a diet consisting of mysids, amphipods, and echinoderms, while larger specimens have a diet consisting of echinoderms and pelecypod molluscs.

During the winter months American plaice inhabit the deeper and warmer waters of the Laurentian Channel. When spring arrives they return to the gulf to spawn, with Sydney Bight being a major spawning area with high concentrations of plaice eggs during the month of May. American plaice eggs are small, buoyant and float on the waters surface for 11-14 days at 5°C before hatching. During the summer months American place remain in the cooler and shallower waters. The 1993 to 2000 RV summer survey catch data are provided in Appendix M.

Pelagic Fish

Atlantic Herring

Atlantic herring is a cold-water, coastal, pelagic species that can be found within waters on both sides of the North Atlantic Ocean. Juveniles undergo complex north-south and inshore-offshore migrations during their lives for spawning, feeding and overwintering (DFO 2010g).

Herring eggs are heavier than water and the demersal eggs are laid on substrates as large as boulders to as fine as sand, shell fragements and even macrophytes. Spawning occurs in the fall to early winter (August to December) in coastal habitats. Eggs are usually laid in waters between 20 and 80 m deep (Scott and Scott 1988) and hatch in 10 to 15 days (DFO 2010g). The larval stage lasts from four to eight months depending on the time of spawning and the associated water temperatures; during this time, the larvae survive on the attached yolk sac and feed opportunistically on zooplankton. The planktonic herring larvae make vertical migrations daily or semi-daily; the purpose for these migrations is not completely understood (DFO 2010g). The larval stage ends in early spring (April to May), when Atlantic herring larvae metamorphose into juveniles. Juveniles form large schools in coastal waters and in the fall and in early winter, move to deep bays or near the seafloor in offshore areas to overwinter (DFO 2010g). Males and females mature at approximately three to four years of age and adults have a diet consisting of euphausiids (krill), chaetognaths and copepods, with the juvenile diet similar to that of the adults (DFO 2010g). The 1993-2000 summer RV survey catch data are presented in Appendix M.

Atlantic Mackerel

Atlantic mackerel belong to the order Perciformes, family Scombridae. The family Scombridae is widely distributed through temperate and tropical waters and of the three species that occupy the genus *Scomber*, the Atlantic mackerel has the most northerly distribution. The Atlantic mackerel is found on the eastern and western coasts of the Atlantic from the Mediterranean to Norway and North Carolina to Newfoundland. In the spring and summer, mackerel are found in coastal waters, where they move to deeper waters in the fall to overwinter (DFO 2007). Within Canadian waters, the Gulf is recognized as prime mackerel spawning grounds. Spawning generally occurs in June and July in coastal regions (Studholme *et al*. 1999). Spawning occurs near the surface and the eggs incubate for approximately one week. During incubation, the eggs float above the thermocline (Studholme *et al*. 1999). Mackerel go through a larval stage where the yolk sac is absorbed into the body over the course of a couple months while fins are being developed. Once the fins are developed and the yolk sacs absorbed, the juvenile mackerel form schools and remain in coastal waters (DFO 2007).

Maturity is reached generally at a younger age than other species and by the age of four, all mackerel are sexually mature. Adult mackerel feed on zooplankton including copepods, planktonic crustaceans, euphausiids, amphipods and chaetognaths.

Capelin

Capelin are small pelagic fish which are preyed heavily upon by many fish including cod, seabirds, seals, and whales (Schaefer *et al*. 2004). They are usually found in cold deep waters off the offshore banks and coastal areas. The species is plentiful on the northern shore of the Gulf of the St. Lawrence, but its highest concentrations can be found off the coast of Newfoundland and Labrador (Scott and Scott 1988). Capelin will move inshore in large numbers to spawn on beaches with coarse sand and fine gravel, where fertilized eggs can become buried up to 15 cm in the substrate. Most capelin traditionally spawn in Newfoundland and Labrador, but there are several traditional spawning areas located in Sydney Bight. The Summer 1993-2000 RV Survey Catch data are provided in Appendix M. Capelin are at a low trophic level, as a result, changes in their abundance can have drastic effects on the survival of other species in the ecosystem. Generally they are not abundant on the Scotian Shelf, but their numbers have been increasing since the mid-1980s, which is thought to be a result of cooler benthic temperatures in the region (Schaefer *et al*. 2004). It is thought that the increased number of capelin on the eastern Scotian Shelf could lead to an increased number of capelin predators such as whales, seals, and seabirds in the area.

Redfish

Redfish are a benthic fish species that live over rocky or silt-clay substrate in cool waters along the slopes of banks at depths typically ranging from 100-700 m (Schaefer *et al*. 2004). Although they are typically a benthic species, their range can vary depending on the season. Redfish are pelagic or benthypelagic feeders that feed primarily on amphipods, copepods, and euphausiids, with increasing amounts of fish as they mature. There are three species of redfish found within the Northwest Atlantic which include: the Acadian redfish (*Sebates faciatuis*), the golden redfish (*Sebates marinus*), and the deepwater redfish (*Sebates mentella*). The Acadian and deepwater redfish are more commonly found in Sydney Bight. The deepwater redfish has a deeper distribution and typically ranges from the Gulf of the St. Lawrence to the north, with the Acadian redfish ranging from the southern Grand Banks to the Gulf of Maine.

During the summer months large concentrations of redfish are found in Sydney Bight and in the southern Gulf of St. Lawrence. During the winter months most redfish can be found in the eastern portions of the Laurentian Channel (Schaefer *et al*. 2004). The 1993-2000 summer RV survey catches of redfish are provided in Appendix M.

5.7.2.7.4 Biologically Sensitive Periods

The principal commercial fish species that could be found in the RAA represent a range of mating and spawning periods (Table 5.7.15). Atlantic mackerel move inshore to spawn in the spring, primarily in the southwestern Gulf of St. Lawrence (Rodger 2006). Atlantic cod also spawn in the spring, although the spawning period can extend into the early fall as well. In the southwestern Gulf, cod spawning typically peaks in late June, although there is substantial diversity in spawning peaks across the population (Scott and Scott 1988). Atlantic cod also spawn at a wide range of depths, from 180 m to over 600 m (Rodger 2006). Witch flounder are known to form large pre-spawning concentrations in the Laurentian Channel in January and February (DFO 2010f). Peak spawning in this area is anticipated to occur in late spring or early summer, based on observations of fish maturity during the January pre-spawning aggregation in the Laurentian Channel (DFO 2010f).

Redfish spawn during the spring and summer months, with a high abundance of larvae in Sydney Bight during April and May (Schaefer *et al*. 2004). Major concentrations of American plaice eggs are found in the area during April and May. The spawning location and timing of white hake have been debated in the literature. It is generally accepted that there are two spawning times, with a shallow water summer spawn and deep water early spring spawn (Schaefer *et al*. 2004). It is believed that an eelgrass bed found in St. Anns Bay may play an important role as habitat for juvenile white hake. Haddock generally spawn in Canadian waters from January to July, although the inshore environment is not generally important for spawning. Atlantic Herring generally spawn during the spring and fall all along the coast from northern Cape Breton to Scatarie Island (Schaefer *et al*. 2004).

The principal commercial shellfish species in the RAA represent a range of mating and spawning periods (Table 5.7.15). The reproductive cycle of a lobster lasts approximately two years. Fertilization of eggs typically occurs in the summer, with hatching occurring 9 to 12 months after fertilization (DFO 2009c). Snow crab mating occurs typically sometime from February to March, with mating pairs migrating to shallow waters in the spring. Female rock crab seems to typically extrude eggs in late October; the eggs mature over the winter and hatch the following spring or summer into free-floating larvae (DFO 2000a). Mature northern shrimp breed in the late autumn or early winter, with the eggs hatching in spring (Rodger 2006). Scallop spawning takes place from late August to early September. They have the potential to mate and spawn over long periods of time, resulting in their reproductive activities ranging over the full year.

Table 5.7.15 Mating and Spawning Periods of Principal Commercial Fish Species in the Vicinity of the Project

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
American plaice	*Hippoglossoides platessoides*				🟧	🟥							
Atlantic halibut	*Hippoglossus hippoglossus*		🟧	🟥	🟧	🟧							
Atlantic herring	*Clupea harengus*								🟧	🟧	🟧	🟧	🟧
Atlantic haddock	*Melanogrammus aeglefinus*	🟧	🟧	🟧	🟧	🟧							
Atlantic mackerel	*Scomber scombrus*						🟧	🟧					
Atlantic cod	*Gadus morhua*					🟧	🟥	🟧	🟧	🟧			
Atlantic bluefin tuna	*Thynnus thynnus*												
Capelin	*Mallotus villosus*						🟧	🟧					
Greenland halibut	*Reinhardtius hippoglossoides*	🟧	🟧	🟧	🟧							🟧	🟧
Monkfish	*Lophius americanus*						🟧	🟧	🟧	🟧			
Redfish (deepwater and Acadian)	*Sebastes mentella/Sebastes fasciatus*			🟧	🟧	🟧	🟧	🟧		▨	▨	▨	▨
Thorny skate	*Raja radiate*	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
White hake	*Urophycis tenuis*					🟧	🟧	🟧	🟧	🟧			
Witch flounder (greysole)	*Glyptocephalus cynoglossus*	🟩	🟩	🟧	🟥	🟥	🟥	🟥	🟧	🟧			
Yellowtail flounder	*Limanda ferruginea*					🟧	🟧	🟧					
Lobster	*Homarus americanus*					🟧	▧	▧	▨				
Snow crab	*Chionoecetes opilio*		▨	▨	🟧	🟧	🟧						
Northern shrimp	*Pandalus borealis*				🟧	🟧			▨	▨	▨	▨	
Rock crab	*Hemigrapsus sexdentatus*					🟧	🟧	🟧	🟧		▨	▨	
Oyster	*Crassostrea virginica*						🟧	🟧					
Mussel	*Mytilus edulis*					🟧	🟧	🟧	🟧				
Sea Urchin	*Strongylocentrotus droebachiensis*				🟧								
Scallop	potential for multiple species							🟧	🟧	🟧			

Scott and Scott 1988; DFO2000a, 2000b,2006a, 2009b, 2009c, 2009d, 2009e, 2009f, 2010a, Cargnelli *et al*. 1999; LGL 2005; Rodger 2006; Schaefer *et al*. 2004.

🟧	potential spawning and hatching periods
🟩	pre-spawning aggregation in Laurentian Channel
🟥	peak spawning period anticipated
▨	mating period
▧	overlap of spawning and mating periods

5.7.2.8 Marine Mammals and Sea Turtles

A total of 25 species of marine mammals and sea turtles can be found in the Gulf of St. Lawrence (LGL 2007). Of these, 14 species of cetaceans and 2 species of sea turtles may be expected to occur with varying frequency in the coastal habitats of Sydney Bight. A summary of these species is provided in Table 5.7.16, noting that the species which are considered at risk are addressed in Section 5.7.2.2.2, including summary information on life histories.

There are two groups of marine mammals which frequent the RAA: the cetatceans, which include whales, dolphins, and porpoises; and pinnipeds, a group that includes seals. The cetaceans can be divided into Mysticetes; the toothless/baleen whales, and Odontocetes; the whales which have teeth. Several marine mammals use the RAA to forage and hunt for prey, moving into the bays along the coast to do so. It is thought that any cetacean species found in the Gulf of the St. Lawrence could be found in the RAA since the Cabot Strait is a known migration route for many species travelling in and out of the Gulf of St. Lawrence (Schefer *et al*. 2004).

Based on the transient nature of cetaceans in the North Atlantic this section will discuss the potential of cetaceans to occur within the Sydney Bight. This area covers the northeastern portion of Cape Breton from Scatarie Island to Cape North.

There are scattered reports of sightings and strandings of cetaceans in Sydney Bight. North Atlantic right whales are occasionally spotted in the area, while a northern bottlenose whale was stranded in Sydney Harbour in 1992. Various other species of whales have also been known to strand themselves on beaches throughout the Sydney Bight area (Schefer *et al*. 2004). Bay St. Lawrence located at the northern tip of Cape Breton, and over 100 km from the Project location, is the only well-studied area in Sydney Bight with regards to marine mammals. Bay St. Lawrence is an area of deep coastal water providing large schools of Atlantic mackerel, herring, and cod for cetaceans to feed on. Fin whales can be found in the area from June to September, minke whales can be found when the Bay is free of ice, pilot whales can be found in the Bay from mid-June to November, with young pilot whales and dolphins using the area for calfing.

Table 5.7.16 Marine Mammals and Sea Turtles Potentially Present Within the RAA

Common Name	Latin Name	Potential Occurrence in relation to the Project
Cetaceans		
Mysticetes (Toothless or Baleen Whales)		
Blue whale^{A}	*Balaenoptera musculus*	Uncommon
Fin whale^{A}	*Balaenoptera physalus*	Common
Humpback whale^{A}	*Megaptera novaeangliae*	Common
Minke whale	*Balaenoptera acutorostrata*	Common
North Atlantic right whale^{A}	*Eubalaena glacialis*	Rare
Odontocetes (Toothed Whales)		
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Common
Beluga	*Delphinapterus leucas*	Rare
Harbour porpoise^{A}	*Phocoena phocoena*	Common
Killer whale^{A}	*Orcinus orca*	Uncommon
Long-finned pilot whale	*Globicephala melas*	Common
Northern bottlenose whale	*Hyperoodon ampullatus*	Uncommon
Sperm whale	*Physeter macrocephalus*	Common
White-beaked dolphin	*Lagenorhynchus albirostris*	Common
Pinnipedea		
Harbour seal	*Phoca vitulina*	Uncommon
Harp seal	*Phoca groenlandica*	Common
Hooded seal	*Crystophora cristata*	Common
Grey seal	*Halichoerus grypus*	Common
Sea Turtles		
Leatherback sea turtle^{A}	*Dermochelys coriacea*	Seasonally Common
Loggerhead turtle^{A}	*Caretta caretta*	Uncommon
^{A} At-risk species discussed in Section 5.7.2.2.2		

5.7.2.8.1 Mysticetes (Toothless/Baleen Whales)

Of the 14 cetacean species found in Sydney Bight, there are six species of baleen whales. Presence of these species in the coastal waters of Sydney Bight is expected to be transitory in nature as the species would likely be migrating to or from feeding grounds in the Gulf of St. Lawrence. The Laurentian Channel and the Magdalen Islands are known feeding areas within the Gulf for baleen whales (DFO 2005). Humpback whales feed in the Gulf during the summer; however, the majority of their sightings have been in the northeastern part of the Gulf. They prefer to breed in waters that have a temperature between 24°C and 28°C and therefore conduct their breeding in southern latitudes during the winter (DFO 2011d). There is evidence that fin whales are present in the Gulf from July to September and tend to migrate through the Laurentian Channel to winter off northern Nova Scotia. Minke whales have also been observed in the Gulf from July to September but are more frequent in the northern Gulf (LGL 2005). Blue whales can be found in the Gulf from January through November; however, they are most abundant from August to October (LGL 2005). North Atlantic right whales are only occasionally sighted in the Gulf and have been seen in the spring and fall seasons in the lower north shore, and to the east of the Gaspé Peninsula (DFO 2011b). They are however, rare in waters off western Newfoundland (LGL 2005d). In 2007, a cetacean distribution study was conducted by DFO, and one area of the survey ranged from southwest Newfoundland to the Magdalen Islands. Several species of Mysticetes were spotted, including blue, humpback and minke whales (Lawson and Gosselin 2009).

Species profiles for the minke whale which may occur in the RAA is described in the following sections. At-risk species for the remaining four baleen whales are described in Section 5.7.2.2.2.

Minke Whale

Minke whales also commonly occur within the Gulf and most likely within Sydney Bight. The size of the Canadian East Coast stock population of minke whales is not well known, but the best available estimate is approximately 3,300 individuals (Waring *et al*. 2009), which does not include all of the range of minke whales in the northwest Atlantic. An estimate of 1,000 minke whales was made in the Gulf during one summer, 600 of which were seen in the northern Gulf (Kingsley and Reeves 1998). A 2007 survey resulted in an estimated abundance of 360 minke whales in the Gulf (Lawson and Gosselin 2009). Minke whales are more commonly sighted during the summer months in Newfoundland waters, but some may stay in the winter. They are commonly seen nearshore in approximately 200 m of water (Hooker *et al*. 1999), but occur offshore in deeper waters. The minke whale diet consists of capelin and sand lance (Naud *et al*. 2003), but they are also known to eat planktonic crustaceans, herring, mackerel and occasionally squid.

5.7.2.8.2 Odontocetes (Toothed Whales)

As presented in Table 5.7.16, there are nine species of toothed whales that could potentially be found in the vicinity of the Project location. The Atlantic white-sided dolphin, harbour porpoise, long-finned pilot whale, sperm whale and white-beaked dolphin are likely to be common in the Sydney Bight region, whereas the common bottlenose dolphin, killer whale, and northern bottlenose whale are likely to be uncommon in this area and the beluga is considered rare (LGL 2005). The distribution of sperm whale is based highly on their social structure, whereby adult females and young are typically found in tropical and subtropical waters and adult males in higher latitude waters. Sperm whales are generally distributed over areas of steep underwater topography, as are the long-finned pilot whales. Sperm whales are capable of diving to depths greater than 1,200 m to feed and can stay submerged for greater than two hours at a time, but the majority of their dives last approximately 30 minutes. The majority of the sightings of the Atlantic white-sided dolphin in the Gulf were also recorded in areas with steep bottom topography. Evidence suggests that the harbour porpoise is common to the northern portion of the Gulf from July to September; however, sightings also show this species to be present in the southern and central portions of the Gulf as well (LGL 2005). It has been noted that a distinct population of harbour porpoise exists in the Gulf and that the species is generally seen close to coastlines (DFO 2011e). Similarly, the beluga population within the Gulf is also believed to be isolated from other beluga populations (DFO 2011e). The Gulf population doesn't appear to migrate far, as they are rarely seen beyond the boundaries of the Gulf.

The cetacean distribution study completed in 2007 (Lawson and Gosselin 2009), which includes the waters off southwest Newfoundland, observed several species of Odontocetes, including harbour porpoise, Long-finned pilot whale and the Atlantic white-sided dolphin. The not-at-risk toothed whales that have the greatest potential to occur in and around the area are described in the following sections. At-risk species are described in Section 5.7.2.2.2.

Atlantic White-sided Dolphin

The Atlantic white-sided dolphin is common from Labrador to Cape Cod with spotty occurrences south of Cape Cod to Maryland (Proctor and Lynch 2005). The North Atlantic population is estimated at several hundred thousand (Reeves *et al*. 1999). Those in the western North Atlantic may be comprised of three distinct populations; Gulf of Maine, Gulf of St. Lawrence and Labrador Sea populations (Palka *et al*. 1997). A population estimate of 12,000 individuals was made during one summer in the Gulf, but the estimate varied greatly during the next summer (Kingsley and Reeves 1998). A 2007 survey resulted in an estimated abundance of 1,044 white-sided dolphins in the Gulf (Lawson and Gosselin 2009).

The Atlantic white-sided dolphin usually travels in groups numbering between 50 and 60, but sometimes number in the hundreds (Reeves *et al.* 1999). They are usually spotted near feeding groups of whales and seabirds and feed on squid and herring. They are most likely to occur within Cabot Strait during summer and fall. The Atlantic white-sided dolphin is not listed under SARA and was declared 'not at risk' by COSEWIC in 1991.

Long-finned Pilot Whale

As indicated in Table 5.7.16, long-finned pilot whales are common in the Gulf and in the vicinity of the Project location. The world-wide population of long-finned pilot whales is estimated at 750,000 individuals. Long-finned pilot whales would be common off the southwest coast of Newfoundland during the summer (Kingsley and Reeves 1998). They are frequently observed along shelf breaks, offshore, but may occur coastally as well. Groups of long-finned pilot whales are occasionally found stranded on beaches. They commonly come close to shore, especially if squid are abundant in the area.

Long-finned pilot whales are a very social species and most often are seen in groups of 10 to 20 individuals, but may also appear in groups of hundreds (Proctor and Lynch 2005). This species favours cold waters near the Continental Shelf well offshore. Squid and pelagic schooling fish species are the primary prey of the long-finned pilot whale. It is considered 'not at risk' and has not been assessed by COSEWIC and is not listed under SARA.

Sperm Whale

Sperm whales are considered common and are occasionally seen in the Gulf. Sperm whales range widely through the world's oceans and males are found off both coasts of Canada and are considered 'not at risk' by COSEWIC. The worldwide population is reasonably large despite historical large reductions by commercial whaling which was discontinued in 1972 in Canada. The population of sperm whales in the western North Atlantic has been estimated to be approximately 4,800 animals. They are most commonly found feeding in the waters above submarine canyons and along the edge of the Continental Shelf in very deep water (Proctor and Lynch 2005). This species routinely dives to depths of hundreds of metres and is capable of remaining submerged for longer than two hours but most dives probably last a half-hour or less (Rice 1989). The sperm whales diet consists of squid and fish.

White-beaked Dolphin

The white-beaked dolphin has a more northern distribution than the white-sided dolphin and is more common north of the Gulf of Maine and very rare south of Cape Cod (Proctor and Lynch 2005). The total population in the North Atlantic could be as high as a few hundred thousand individuals (Reeves *et al*. 1999). Although they are genetically distinct, white-beaked dolphins do occur on both sides of the North Atlantic, with the largest population off Labrador and southwestern Greenland. The white-beaked dolphin feeds mainly on squid, although it will also take fish. The white-beaked dolphin was declared 'not at risk' by COSEWIC in 1998 and is not listed under SARA.

5.7.2.8.3 Pinnipeds (Seals)

Pinnepeds are a group of marine mammals which haulout onto shore to give birth and suckle their young. Four species of seals can be found in Sydney Bight including: grey, harbour, harp and hooded seals. All of the species can be found in the area during the winter with both grey and harbour seals remaining in the summer and harp and hooded seals leaving around April or May (Schaefer *et al*. 2004).

Information regarding the distribution and habitat of seals along the Atlantic coast of Nova Scotia is relatively unknown, specifically in the Sydney Bight Area. Haulout areas have been noted on the northern shore of the Donkin Peninsula as well as on both shorelines of South Head. Additional areas in Sydney Bight which are known to be frequented by seals are the Bird Islands and Hay Islands (Schaefer *et al*. 2004). The Bird Islands are used as a haulout site by grey seals from mid-August to early September. There is also a small Grey seal rookery on the Hay Islands (located off Scatarie Island). It is thought that harbour seal rookeries may exist in the coastal areas of Sydney Bight, although it is difficult to identify these areas due to the fact that harbour seals pupping takes place over a few hours at low tide, with both the mother and pups swimming away by the next high tide (Schaefer *et al.*, 2004).

Harp Seal

Harp seals whelp during the spring predominantly in an area known as the ‘Front’ off southern Labrador and northeastern Newfoundland (Sergeant 1991; DFO 2000d). Individuals from these two areas spend the summer months in the Canadian Archipelago, Davis Strait and Baffin Bay and then migrate approximately 10,000 km south along the Newfoundland and Labrador coast and Gulf (Whitaker 1996). In recent years, there has been an apparent change in their distribution as more harp seals are occurring south of this area. McAlpine *et al*. (1999) documented an increase in extralimital occurrences (south of normal range) of harp seals in the northern Gulf of Maine. The total population in 2004 was estimated at 5.9 million (ICES 2005).

Arctic cod (*Boreogadus saida*) is the primary food of the harp seal, comprising an estimated 54 percent of their diet from October to March (DFO 2000d), but this tends to vary with age, season, year and location (Kapel 2000; Nilssen *et al*. 2000). Capelin, followed by sand lance, Greenland halibut and other flatfish are the preferred prey of harp seals (Wallace and Lawson 1997). Harp seals consume less Atlantic cod than once believed as seals apparently spend more time offshore than previously thought (Hammill and Stenson 2000).

Hooded Seal

Like the harp seal, the majority of the hooded seal population in the Atlantic whelp in the area off southern Labrador and Northern Newfoundland in mid- to late March (Lyderson and Kovaks 1999). The southern Gulf is also one of several whelping habitats for the hooded seal. Congregations occur in March and April near Prince Edward Island and the Magdalen Islands for pupping and breeding. They then migrate northward to the sub-Arctic and Arctic (to the waters off Greenland) to feed during the summer (Lydersen and Kovacs 1999). Hooded seals are widely distributed throughout the western North Atlantic in the winter and spring (Stenson and Sjare 1997; Kovacs 2002); however, some individuals may remain in Atlantic waters year round. Population estimates are on the order of 500,000 seals (Kovacs 2002), a small portion of which whelps in the southern Gulf (Hammill 1993). Hooded seals feed on benthic invertebrates, Greenland halibut, redfish, Arctic cod and squid.

Grey Seal

The Northwest Atlantic stock of grey seals occurs in the Gulf, off Nova Scotia and Newfoundland and Labrador. Grey seals on the Grand Banks are likely from the Sable Island and Gulf breeding populations. The largest breeding colony occurs on Sable Island, with a range of 208,000 to 223,000 individuals (Trzcinski *et al*. 2005) and the Gulf population (which pups on the ice in the southern Gulf) is estimated at 52,500 (Hammill 2005), which accounts for all of the pup production in the northwest Atlantic. Grey seals also congregate in the Gulf, between the eastern end of Prince Edward Island and Cape Breton Island and on the ice in St. George’s Bay, for pupping and breeding from mid-December to late February (Stobo and

Zwanenburg 1990). Grey seals will most likely occur in the Gulf during July and August but could potentially be present year-round (Stenson 1994).

Grey seals are benthic and pelagic predators of at least 40 species including Atlantic cod, herring, squid and mackerel (Benoit and Bowen 1990; Hammill *et al*. 1995).

Harbour Seal

Harbour seals are year-round residents of the Gulf, the St. Lawrence estuary and coastal Newfoundland (Burns 2002). The primary prey of harbour seals is winter flounder, Arctic cod, shorthorn sculpin (*Myoxocephalus scorpius*) and Atlantic cod, with some regional variability (Sjare *et al*. 2005). Harbour seals are common in nearshore, shallow waters near river mouths or at particular haul-out sites. Pupping is expected to occur in May or June and pups are nursed for approximately 24 days (Bowen *et al*. 2001). The pups spend time in the water with the mother following weaning.

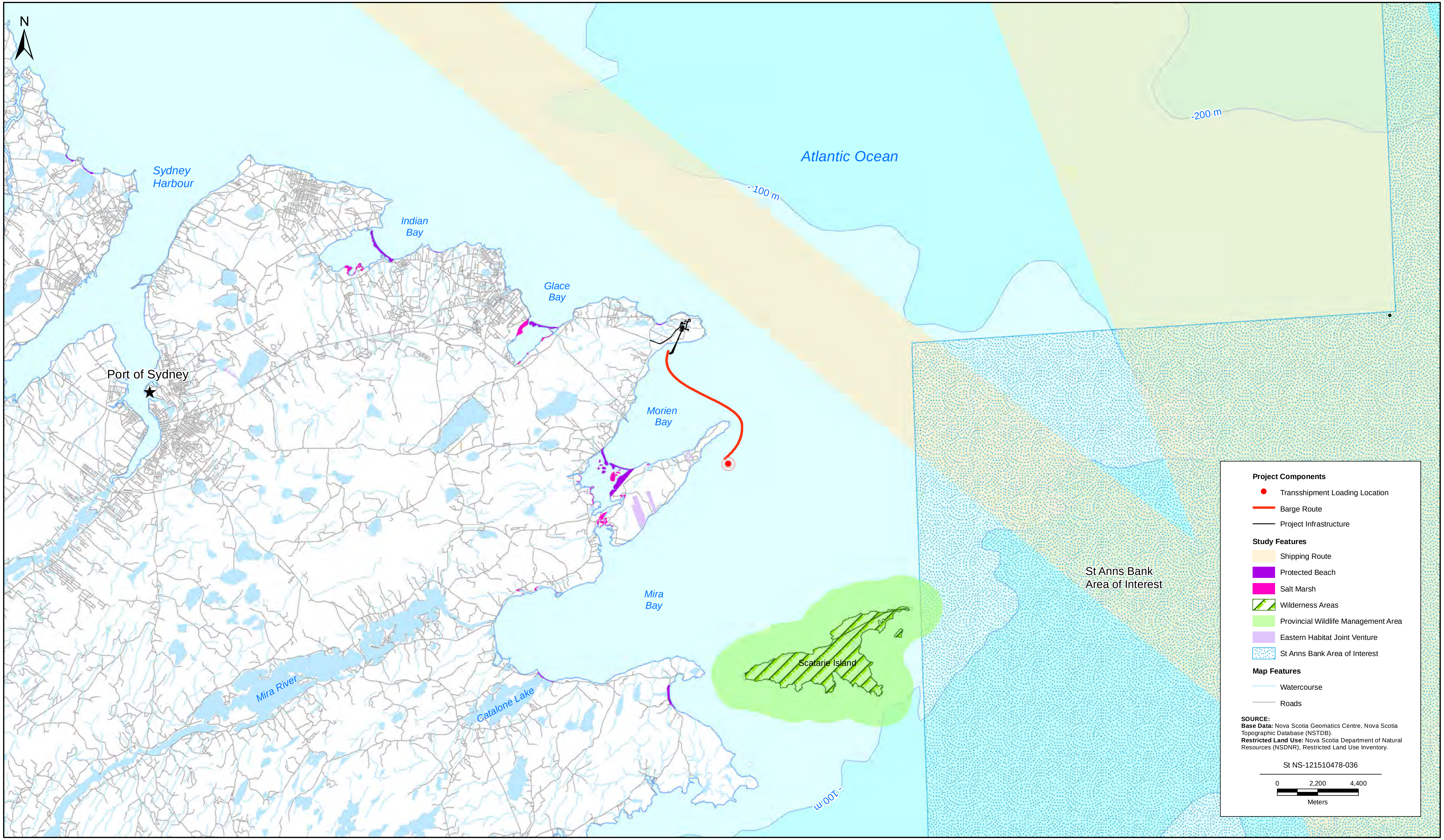
Harbour seals are commonly found in coastal waters, as a result they may be found in the RAA. The eastern Canadian population of harbour seals was estimated at 30,000 to 40,000 individuals in 1993 (Burns 2002). Harbour seals are not listed by SARA and considered to have data gaps by COSEWIC, insufficient to determine the status of the population; however, the east coast population appears to be increasing (Baird 2001).

5.7.2.8.4 Sea Turtles

There are two species of sea turtles that could potentially be found in the RAA (Table 5.7.16). The leatherback and loggerhead sea turtles are considered at-risk species and are discussed in Section 5.7.2.2.3

5.7.2.9 Sensitive Areas

The RAA contains several distinct habitats, some of which are located in close proximity to the Project location. Areas within the RAA include sensitive habitats for many marine species. These areas are described below. Figure 5.7.11 represents the general significant areas located in the RAA pertinent to the Marine Environment as well as the location of St. Anns Bank Area of Interest.



SOURCE:
Base Data: Nova Scotia Geomatics Centre, Nova Scotia Topographic Database (NSTDB).
Restricted Land Use: Nova Scotia Department of Natural Resources (NSDNR), Restricted Land Use Inventory.

PREPARED BY:
K Keizer

REVIEWED BY:
M Steeves

CLIENT:
xstrata coal

Donkin Export Coking Coal Project

The Location of Marine Sensitive Areas in the RAA

FIGURE NO.:
5.7.11

DATE:
Apr 25, 2012

Stantec

File Path: V:\1215\active\121510xxx\121510478-Donkin Mine Enviro Assessment\geomatics\mapping\mxd\EA_Final\ST_NS_121510478_036_Marine_Sensitive_Areas.mxd

Scatarie Island

In relation to the Marine Environment, Scatarie Island is of ecological significance as it contains several known seal haulout sites, with a grey seal rookery site located on Hay Island to the east. Scatarie Island is a provincially protected wilderness area. There are also several areas of bottom habitat surrounding the Island that provide good habitat for scallops (Schaefer *et al*. 2004). Scatarie Island has important spawning areas for Atlantic herring as well as potential areas for juvenile fish refuge along its coastline (Gromack *et al*. 2010). The area also encompasses important habitats such as marine algae and eelgrass beds.

Mira Bay/Mira River

Throughout Mira Bay, scallop habitat can be found, as well as several seal haulouts along the shoreline. Two Atlantic salmon rivers flow into Mira Bay; the Mira River and the Catalone River. A population of lake whitefish, which is thought to be distinct from other populations, is also found in the Mira River (Schaefer *et al*. 2004). Mira Bay has very high biodiversity as it was one of three sites with the highest diversity of species caught in gillnets during a 2007 study (Gromack *et al*. 2010). There are moderate-sized eelgrass beds located in the Mira Gut.

Morien Bay

Morien Bay contains a variety of habitat types which are important for marine species in the area including a substantial salt marsh, as well as eelgrass beds as described in Section 5.7.2.5. Morien Bay also supports harvesting for baitworms, scallop habitat, and seal haulout areas (Schaefer *et al*. 2004).

St. Anns Bank

St. Anns Bank is a DFO designated Area of Interest (AOI) located east of Scatarie Island. DFO is considering designation of St Anns Bank as a Marine Protected Area (MPA) under the Canada's *Oceans Act*. An AOI carries no particular regulatory restriction; however, an MPA may restrict various activities such as fishing and resource development. This area covers approximately 5100 km^2 including parts of St. Anns Bank, Scatarie Bank, and a section of the Laurentian Slope and Channel (DFO 2011e). These features provide a diverse habitat for commercial species, non-commercial species, and several at-risk species. The area is also an important overwintering area for resident and southern Gulf of St. Lawrence Atlantic cod populations. The area is also in an important migration route for a variety of marine mammals and fish species. Fish and mammal species known to migrate throughout the area range from small fish such as mackerel and herring to bluefin tuna, as well as blue and humpback whales. The area is a well-known herring feeding and spawning area, as well as an overwintering area for the Bras d'Or Lakes herring. The area is also known to harbour white hake, during their nursery and juvenile stages. The North River runs into St. Anns Harbour, containing some important species including the most important salmon stock in Sydney Bight (Schaefer *et al*. 2004).

The St. Anns Bank is also of interest for sensitive bottom habitats and species, including cold water corals. The area also contains scallop bottom habitat, substantial eelgrass beds, and baitworm harvesting (Schaefer *et al*. 2004).

5.7.3 Potential Project-VEC Interactions

Table 5.7.17 below lists each Project activity and physical work for the Project, and ranks each interaction as 0, 1, or 2 based on the level of interaction each activity or physical work will have with the Marine Environment.

Table 5.7.17 Potential Project Environmental Effects on the Marine Environment

Project Activities and Physical Works	Potential Environmental Effects	
	Change in Marine Habitat	Change in Mortality Risk
Construction		
Site Preparation (incl. clearing, grading and excavation)	0	0
Construction of Mine Site Infrastructure and Underground Preparation	0	0
Construction of 138 kV Transmission Line	0	0
Construction of Barge Load-out Facility (incl. infilling, pile-driving, and habitat compensation)	2	2
Installation of Transshipment Mooring	2	2
Operation and Maintenance		
Underground Mining	0	0
Coal Handling and Preparation (incl. coal washing and conveyance)	0	0
Water Treatment (incl. mine water and surface runoff)	1	1
Coal and Waste Rock Disposal	0	0
Ongoing Sweep of Mooring Anchor Chains	1	1
Marine Loading and Transportation	2	1
Coal Trucking	0	0
Decommissioning and Reclamation		
Site Decommissioning	1	1
Site Reclamation	1	1

0 = No interaction
1 = Interaction occurs; however, based on past experience and professional judgment, the resulting effect can be managed to acceptable levels through standard operating practices and/or through the application of best management or codified practices. No further assessment is warranted.
2 = Interaction occurs, and resulting effect may exceed acceptable levels without implementation of specified mitigation. Further assessment is warranted.

Rationale for the potential interaction ranks in Table 5.7.17 is provided in the following section.

Within the construction phase; site preparation, construction of mine infrastructure, underground preparation and construction of the 138 kV transmission line were all deemed to have no interaction with the Marine Environment. The foundation of these activities occur on land and through adherence to appropriate Best Management Practices (BMP) for erosion and sediment control as described in the Nova Scotia Environment Erosion and Sediment Control Handbook for Construction Sites and confirmed by routine water quality monitoring, no interaction with the Marine Environment would be expected. The environmental effects of these activities on the Marine Environment are therefore rated not significant and there is no further consideration of these activities in the assessment.

During the construction of the barge load-out facility and the transshipment mooring, destruction of fish is possible within the footprint of the barge load-out wharf and the anchor locations for the barge swing circle and the transshipment location. Direct mortality of sessile species or species with decreased mobility is anticipated with the installation of anchor points for the barge swing circle and transshipment location, and the armour stone and similar materials used to create the base for the barge load-out wharf and breakwater structure. Benthic habitat will be altered, damaged or destroyed in the footprint of the barge load-out wharf with the installation of caissons or timber cribwork required for the base of the wharf. The underwater acoustic environment in the PDA and LAA will change during construction with an increase in sound levels from the infilling for the construction of the breakwater and increased vessel traffic.

During operation and maintenance of the mine, environmental effects from underground mining, coal handling and preparation, and coal and waste rock disposal are not anticipated to interact with the Marine Environment. The underground mining shaft entrances and processing infrastructure are land-based, with extraction of the subsea coal seams occurring in tunnels hundreds of metres below the seafloor. Mitigation of seafloor subsidence will occur through adherence to standard mine engineering criteria to ensure tunnel stability and integrity.

Coal handling and preparation will be performed on the Donkin Peninsula in enclosed buildings and conveyors with appropriate dust control and therefore will not interact with the Marine Environment. Coal and waste rock disposal will be land-based and contained within a disposal system described in Section 2.7.1.1. Any effluent arising from either the coal handling and preparation or coal and waste rock disposal will be processed through a water treatment system and the environmental effects on the Marine Environment is addressed below. Based on the contained and land-based nature of the underground mining, coal handling and preparation, and coal and waste rock disposal, these Project activities are not anticipated to interact with the Marine Environment.

Effluent from the mine and site drainage will be treated on site through a combination of the use of the current passive water treatment system and/or the active treatment system to be installed prior to construction. The passive system consists of an aeration cascade, primary sedimentation pond, serpentine channels and a secondary (DEVCO) sedimentation pond before release into the marine environment on the north coast of the Donkin Peninsula. In recognition of the potential change to acidic water conditions from runoff from coal waste disposal piles as the Project proceeds to the production phase, additional active water treatment systems will be required in addition to the current passive system. Although detailed design has not yet been initiated, it is anticipated that new drainage channels will direct site drainage to a new holding pond likely to be located in the vicinity of the serpentine pond. A water treatment plant will neutralize the acidic water and treated water would then flow into the serpentine pond. Further information is contained in Sections 2.7.2.3.

Existing water quality monitoring is envisaged to form the basis for the life of the Project and occurs semi-monthly through four surface water quality monitoring stations. It has identified levels of iron, zinc, total suspended solids (TSS) and conductivity as indicator parameters. Quarterly toxicity testing on rainbow trout (*Oncorhynchus mykiss*) is also part of the existing monitoring program and has occurred since June 2006 with no toxic results to date. The freshwater characteristics of the effluent will mix once it is released into the marine environment because of the higher wave energy along the exposed northern coast of the Donkin Peninsula. Sanitary sewage will be treated onsite using a package wastewater treatment plant. Water treatment was ranked a 1 because no significant effects on the marine environment are anticipated based on the efficacy of the treatment system and the historical results to date. Further information on the water treatment operations and results of historical water quality sampling is found in Sections 2.7.2.3 and 5.2, respectively.

During the operation and maintenance phase of the project, specifically during the conveyance of coal from the overland conveyor to the barges moored at the barge load-out wharf and the transshipment location, it is anticipated that small amounts of coal may be lost during the transfer process from land to the barge at the barge load-out facility, and again from the barge to the bulk carrier at the transshipment mooring. The amount of coal lost during the movement of barges from the barge load-out wharf to the transshipment location is anticipated to be minimal because of appropriate freeboard design of the barges, moisture content of the product coal and coal containment strategies proposed (see Section 2.7.6). The interaction caused by the potential deposition of coal into the Marine Environment is anticipated to be very localized to habitats within the PDA, and specifically adjacent to the barge load-out facility and within the transshipment mooring location. The coal will be processed on land prior to loading onto barges and the product coal is anticipated to range in size from 1.4 mm to 50 mm, which is too coarse to smother benthic habitat, even with repeated loss of coal, and too small to cause direct mortality to fish through crushing.

The transhipment mooring will be held in place by four, high-capacity type anchors connected with chain legs. Dependent upon current, wave and tidal conditions, one or more chains may be slack at any one time. This may lead to an ongoing sweep of the seafloor leading to a destabilizing effect on the substrate. However, due to the anchor system’s four-point design the range disturbance will be minimal as the chains can only move a short distance in any one direction. Further information regarding the transhipment mooring design can be found in Section 2.4.3.

The underwater acoustic environment in the LAA may be changed during operation because of increased sound levels emitted from the increase in vessel traffic and primarily from tugboats around the barge load-out wharf and from the bulk carriers and tugboats at the transshipment mooring location. The marine loading and transportation activities of the Project during operation have been ranked a 2 for potential interaction and environment effects on the Marine Environment and are therefore carried forward in the assessment.

Site reclamation will progress with the operation and is a land-based activity located at a distance from the marine environment. Adherence to all erosion and sedimentation guidelines/BMPs and monitoring for acid rock drainage will result in no interaction with the Marine.

Site decommissioning is primarily a land-based activity. The barge load-out wharf and breakwater will remain in place during decommissioning and reclamation as a potential public amenity during the post closure phase. It is expected that marine organisms and communities will have been established on the structures and it would be counterproductive to remove them. The swing circle and transshipment moorings may be left in place, depending on the establishment of marine communities and at the discretion of regulatory officials (DFO and Transport Canada). Removal of the conveyor system and various pieces of infrastructure from the barge load-out facility is expected to occur over a short timeframe with no significant disturbance to the Marine Environment. Site decommissioning and reclamation is expected to have only a minimal interaction with the Marine Environment due to the effectiveness of mitigation and the scope of work.

In consideration of the nature of the interactions of the Project on the Marine Environment and the planned implementation of known and proven mitigation, the potential interaction of all project activities and physical works that were ranked as 0 or 1 in Table 5.7.17, are not considered further in the assessment. Further assessment is warranted for project activities that ranked a 2 in Table 5.7.17. These project activities interact with the Marine Environment and are therefore the subject of further assessment.

5.7.4 Assessment of Project-Related Environmental Effects

An assessment of environmental effects, description of mitigation measures and prediction of residual environmental effects has been conducted for all the project tasks that were ranked a 2 in Table 5.7.17 and include the following project tasks broken down by phase:

Construction

- Construction of the barge load-out facility

- Installation of the transshipment mooring

Operation and Maintenance

- Marine loading and transportation

5.7.4.1 Assessment of Change in Marine Habitat

5.7.4.1.1 Potential Environmental Effects

Marine habitat will be altered, disrupted or destroyed through the construction of the barge load-out facility and the transshipment mooring location. Construction of marine-based infrastructure (breakwaters or wharf) will affect marine habitat through a change in available substrate and size distribution, change in water quality (increase in TSS), or change in the acoustic qualities of the marine environment from construction sound levels. During the operation and maintenance phase of the Project, specifically, during the conveyance of coal from the overland conveyor to the barges, moored at the barge load-out wharf and the transshipment location, it is anticipated that small amounts of coal will be lost during the transfer from land to the barge at the barge load-out facility and again from the barge to bulk carriers at the transshipment location. Coal deposition along the barge transit route is anticipated to be minimal during the movement of barges from the barge load-out wharf to the transshipment location. As the coal will be processed prior to loading onto barges, the product coal is anticipated to be in the size range of 1.4 mm to 50 mm. This range of particle sizes will not result in direct mortality to fish or smother benthic habitat. Large quantities and/or repeated deposition of coal into the marine environment could reduce the quality of the substrate and therefore affect fish habitat. The generation of potential coal dust at the mine site may also deposit in the marine environment and affect benthic habitat.

Construction of the breakwater and wharf for the barge load-out facility will have localized direct environmental effects on marine habitat. Infilling required for the construction of the breakwater will destroy existing benthic habitat within the footprint of the breakwater. The placement of caissons or timber piles to support the wharf decking will also destroy existing benthic habitat, albeit a smaller footprint than for the breakwater. The direct environmental effect on the marine environment from the construction of the breakwater structure is limited to the proposed footprint of the breakwater structure as well as the footprint of any piles or caissons required for wharf construction. The breakwater and wharf are expected to be permanent and therefore the interaction with the Marine Environment will extend beyond the decommissioning and reclamation phases of the Project.

The construction of the barge load-out facility may change the water currents along the southern coast of the Donkin Peninsula. The change in the currents may lead to increased deposition of sediments in the lee of the breakwater structure. This sediment deposition may alter substrate characteristics such as reducing hard substrate surfaces and the infilling of interstitial spaces. The reduction of hard surfaces may reduce habitat use by sessile fauna and flora and the reduction of interstitial spaces. The alteration of currents and sediment deposition would likely be limited to the LAA and the interaction with the Marine Environment will extend beyond the decommissioning and reclamation phase.

Decreased water quality from the introduction or re-suspension of sediments in the water column may be increased due to the infilling required for the construction of the breakwater and during anchoring of moorings for a very limited period. TSS levels vary naturally, both spatially and temporally, in coastal marine environments with lowest levels found offshore in calm conditions and highest in the nearshore during turbulent conditions or heavy precipitation events. At high concentrations or during extended periods of exposure, environmental effects of suspended sediments on fish include: decreased feeding success, reduced ability to see and avoid predators, damaged gills, reduced growth rates, decreased resistance to disease or impaired development of embryos (CCME 2002). An increase in TSS will also reduce the amount of light reaching any submerged vegetation (Dunton *et al*. 2009), thereby decreasing the growth of photosynthetic algae. Higher TSS levels are also associated with nearshore areas, and lower production values (Aumack *et al.* 2007). Waters with a high TSS levels have also been found to have significantly reduced amount of periphyton, a benthic organism indicator (CCME 2002). Decreased water quality is limited to the duration for the construction for the barge load-out facility, and for moorings' anchors at much shorter period, and is likely to occur within the LAA.

Construction and installation of the barge load-out facility and the transshipment mooring will generate noise and increase sound levels in the underwater acoustic environment. The majority of anthropogenic sound in the marine environment generated through project construction will predominantly originate from infilling as no pile driving or marine blasting is required. There have been few studies on environmental effects of high levels of ambient sound on fish (Smith *et al*. 2004). Fish take advantage of the rapid propagation of sound through water to perceive and discriminate sounds in the marine environment to perceive both prey and predator (Smith *et al*. 2004). Most fish species have the ability to detect low frequency sounds over great distances (Chapman 1973), such as those produced by impact generating activities. Behavioral responses to loud sounds may include swimming away from the sound source that could result in leaving a primary feeding or spawning area (Popper 2003). Increased sound levels from infilling are anticipated to occur during construction of the barge load-out facility and limited to the extent of the LAA.

Marine habitat may be altered or disrupted from the marine loading and transportation of coal. Marine loading and transportation operations may affect marine habitat through a chemical alteration in substrate quality and the ambient acoustic environment may be disrupted from an increase in ambient sound levels from increased vessel traffic.

Any adverse environmental effect associated with substrate quality would primarily affect the proximal benthic communities. A decrease in substrate quality caused by the introduction of product coal fragments into the environment could cause exceedance of CCME Interim Marine

Sediment Quality Guidelines (ISQG) or the Probable Effect Levels (PEL) for trace metals. The ISQG generally indicate levels for various parameters (*e.g.*, metals, hydrocarbons, polychlorinated biphenyls (PCBs)) at which there is a low likelihood of adverse biological environmental effects, while the PEL represents the concentrations of the same parameters that are associated with adverse biological environmental effects. These guidelines should be regarded as interpretative tools, and local conditions such as existing chemical composition of the substrate, assimilative capacity, sensitivity of endangered species and habitat should be taken into account when evaluating sediment quality at a specific site (CCME 1995). The effect from the introduction of coal into the Marine Environment is expected to be limited to the PDA surrounding the barge load-out facility and the transshipment mooring and occur infrequently during the operation and maintenance of the Project.

The Project may introduce particulate matter (coal dust) into the Atmospheric Environment from the transportation of coal. This dust will disperse based on the prevalent and local wind conditions and may deposit in the Marine Environment, and like for coal, is expected to be limited to the PDA.

The acoustic qualities of the Marine Environment are expected to change during the operation and maintenance phase of the Project. This change in marine acoustics will originate from additional vessel traffic in the LAA (tugboats and barges) and the RAA (bulk carriers). The environmental effects on fish habitat during operation are similar to those discussed for the construction phase. Though elevated sound levels will be lengthier in duration, they are anticipated to be reduced in intensity.

As part of normal operation of the Project during loading of raw coal onto a vessel, ballast water will be discharged from the vessel. Ballast water is carried in tanks that are segregated from all other tanks and void spaces on board, and are designed only for the carriage of water ballast. The piping from the tanks is dedicated for this purpose. Ballast water will be discharged only from vessels that are arriving to receive product coal.

Only the interactions ranked as 2 in Table 5.7.17 were considered further in the assessment of Project-related environmental effects. All other interactions previously ranked as 0 or 1 were rated as not significant.

5.7.4.1.2 Mitigation of Project Environmental Effects

Mitigation of environmental effects on fish habitat associated with the construction of the barge load-out wharf and transshipment location include:

- Geotechnical/Engineering investigations into wharf and breakwater construction methods to reduce the quantity of materials placed in the marine environment (*i.e.*, marine footprint).
- The Project will obtain DFO Authorization for the Harmful Alteration, Disruption or Destruction (HADD) of fish habitat at the barge load-out facility location prior to conducting

infilling operations. To compensate for the direct loss of benthic habitat, the Project will be required to create new habitat (or improve existing habitat) to meet DFO's policy of no net loss under the *Fisheries Act*. The type and area of habitat to be created/enhanced will be detailed in a Habitat Compensation Agreement signed by both the Project and DFO. The specifications of the HADD compensation program will depend on the type of habitat compensation employed and assessed ecological value of existing habitat at the proposed infill site (refer to Section 5.7.2.4.3 for more information on the benthic habitat at the barge load-out facility). A conceptual fish habitat compensation plan for the HADD is presented in Section 5.7.5.1.3 and Appendix G.

- Barges will have appropriate freeboard design and efficient material handling to reduce product losses to the environment. (*i.e.*, no barge overloading, avoiding transiting in high sea states).
- Product coal will be appropriately handled to reduce the potential for coal dust lift-off (ie. stockpile screens, enclosed conveyor and transfer points, telescopic chute at barge load-out facility, sprays and other covers, etc.)
- Project vessels will comply with applicable legislation, codes and standards of practice for shipping, including the *Ballast Water Control and Management Regulations* under the *Shipping Act* to reduce risk of introduction of marine invasive species.
- The contractor will be required to use fill material for the breakwater to be free of fines, debris and any substances that would be deleterious to the marine environment.
- Vessels will travel at reduced speeds near the barge load-out facility, the transshipment facility and points between which will reduce underwater noise.

5.7.4.1.3 Characterization of Residual Project Environmental Effects

Residual environmental effects to marine habitat are anticipated to occur through Project-related changes to: habitat area; water quality; substrate quality; and the acoustic environment. This section addresses direct environmental effects on fish habitat. Changes in terms of the risk to fish mortality are addressed in Section 5.7.5.2.

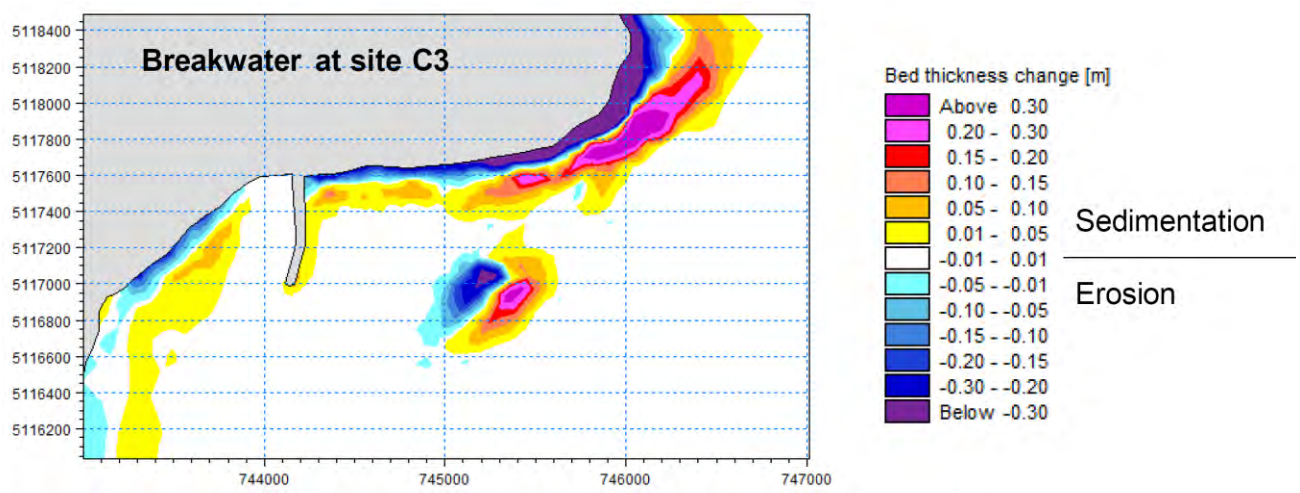
The proposed barge load-out facility consists of a 731 m long, angled breakwater and a 330 m long wharf on the lee side. The breakwater structure will be constructed through infilling with core stone and subsequent placement of two sizes of armour stone. The wharf will be constructed through the placement of concrete caissons or timber cribwork. The breakwater and wharf structure is further described in Section 2.0, Figure 2.4.2 and 2.4.3.

Construction of the barge load-out facility's breakwater will not result in a barrier to fish movements. The breakwater extends approximately 660 m in a straight line from the shoreline into the marine environment within an area of similar water depths and habitat. The requirement of fish to swim around this structure is not expected to result in decreased fish movement in the LAA. The installation of the barge swing circle and transshipment mooring anchors and tethers will not present a barrier to fish movement.

During the construction of the barge load-out facility the infilling for the breakwater and the placement of concrete caissions/construction of timber cribwork for the wharf may result in re-suspension of fine sediments within the PDA. This mobilized fine sediment may be transported and subsequently deposited in areas within the LAA. The substrate within the PDA was determined to be primarily rock in the cobble-to-rubble size range with a much smaller fraction of fine substrate (gravel and sand) observed in between the larger rocks. The natural conditions of the marine benthic environment, including substrate type, water current profiles and abundance of macrofloral vegetation, limit the quantity of available sediment for re-suspension and potential for sediment transport; therefore, the use of turbidity curtains surrounding the construction of the breakwater and wharf, although effective for reducing the geographic extent of any sediment plume, are likely not needed for mitigation purposes. The turbulence and lack of laminar currents observed in the water column surrounding the barge load-out facility are not conducive for the dispersion of any sediment plumes from marine construction activities and would limit the zone of influence. The contractor will be required to use fill material for the breakwater to be free of fines, debris and any substances that would be deleterious to the marine environment. Once construction is complete, concentrations of TSS in the water column is expected to return to background levels within hours. The re-suspension of fine substrate in the water column and the associated decrease in water quality during construction is anticipated to be minimal in magnitude, localized in geographic extent, and short in duration.

Coastal modelling (CBCL 2012) has shown that the construction of a breakwater on the south coast of the Donkin Peninsula is not anticipated to alter the current patterns in the PDA sufficiently to significantly increase sedimentation on the lee side of the wharf or increase sedimentation rates within the LAA. Figure 5.7.12 illustrates the net sedimentation/erosion after three consecutive 1-year storms where the predicted deposition is between -0.01 m and 0.01 m within the PDA. This predicted deposition in the PDA is less than the predicted deposition caused by natural erosion of the sandstone cliffs along the shoreline, where coastal deposition depths measure up to >0.30 m (CBCL 2012).

Figure 5.7.12 Modelled Trend in Sedimentation with Wave and Tidal Current Forcings and the Breakwater



CBCL (2012)

Sediment quality may interact with marine habitat during construction and operation and maintenance of the Project. The characterization of existing marine sediments at the transshipment mooring location (and around the Donkin Peninsula by CBCL) was provided in Section 5.7.2.4.3. All of the chemical parameters analyzed in sediments at the transshipment mooring location and barge load-out facility were below the CCME Interim Marine Sediment Quality Guidelines (ISQG) (Table 5.7.11). This suggests that the risk of acute or chronic toxicity on marine populations from these sediments is low.

The deposition of coal in the marine environment may occur during operation of the Project. Deposition is most likely to occur surrounding the loading of barges from the radial stacker in the barge load-out facility and the loading of the bulk carriers at the transshipment location. The deposition of coal within the PDA may alter the chemical properties of the substrate in the Marine Environment. Of particular interest is the release of trace metals from coal into the marine environment through leaching. This coal leachate has the potential to chemically alter the substrate surrounding the coal deposition. Soluble metals from coal were shown to have different affinities to solutions based on their pH (Ohki *et al.* 2004, Wang *et al*. 1999). As the pH of the solution increased the concentration of soluble metals decreased. Metal concentrations in leachate from coal were analyzed to determine the leaching rates of trace metals. These studies indicate that without the addition of acids or chelating agents, metals leaching from coal are highly unlikely, especially in alkaline seawater (Cabon *et al*. 2007, Ohki *et al.* 2004, Wang *et al*. 1999).

In acidic conditions, comparative coal leachate analysis was conducted using raw coal. The analysis of the leachate for metals of toxic concern (Pb, Zn, Ni, As, and Sr) determined that Pb, (lead), is the element most strongly leached from raw coal at a pH of 6.5 (Wang *et al*. 1999). Lead was measured at leaching rates of 15 percent of the levels of total Pb in raw coal. Arsenic, zinc and nickel were determined to be moderately leachable with rates of 2.47, 1.80, and 1.61 percent, respectively (Wang *et al*. 1999). Strontium was determined to be the metal tested with the lowest leaching rate of 0.35 percent.

In freshwater at a pH of approximately 7 or neutral, metal concentration in coal leachate was less than 2 percent of total metal concentrations in raw coal for Al, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn. Calcium and magnesium were measured at the highest leaching rates of 11 and 8 percent of total metal concentrations in raw coal, respectively (Ohki *et al.* 2004).

Seawater at a pH of approximately 8.1 was used as the solution to analyze the concentration of metals leaching from raw coal. Using seawater it was determined that trace metals from raw coal will not be easily released into the leachate (Cabon *et al*. 2007). Three elements were measured in detectable concentrations in coal seawater leachate; manganese, nickel and zinc. Manganese was the element most highly leached from coal to seawater, followed by nickel and zinc. Copper, chromium, iron and lead were not significantly leached from coal into seawater.

The results of these studies indicate coal deposition in the marine environment may lead to increased concentrations of manganese, nickel and zinc. The effects on the marine environment from changes in substrate quality are anticipated to be very localized to within a 120 m section of the wharf and which equates to the length of a barge, plus 10 m on either end. This section of coal deposition will be static during the operation of the Project as it is located beneath the radial stacker on the lee side of the breakwater. The secondary area of deposition of coal is from loading the bulk carriers, which is also expected to be localized and restricted to the swing circle (PDA) of the transshipment single buoy mooring. Currents in this area are weak as observed during the field studies (Section 5.7.2.3.2) and predicted from modeling studies by CBCL (2012). The water depths in this location are moderate at 24 m and combined with the measured current velocities between 0.1 - 0.2 m/s, the deposition of coal is anticipated to occur within an area radiating 80 to 300 m from the center of the transshipment mooring location. Deposition at this location will not be as static as for the barge load-out facility because of the currents and the fact that the bulk carrier and barges are free to pivot on the mooring into the dominant wind direction.

Coal dust may be generated by the Project and transported by the atmosphere. This dust will disperse based on the prevalent and local wind conditions and may deposit in the Marine Environment. The density of coal dust was determined to be 1.39 g/cm^3 in a study on coal dust dispersal around a marine coal terminal in British Columbia (Johnson and Bustin 2006). Once in the marine environment, the specific gravity of coal, which is slightly higher than that of seawater at approximately 1.03 g/cm^3, indicates that coal dust would settle to the seafloor once entrained in the water column. In the same study, the smallest fraction of coal dust (<53 µm) was observed to remain on the surface of the water, though not in all cases. This observation of fine dust on the surface of the water may be caused by surface tension and the hydrophobicity of coal (Johnson and Bustin 2006). Samples of coal dust <53 µm entrained in the water column did settle at a rate of 0.16 cm/s, which is the slowest rate observed during the study. As particle size increased, the rate of settling also increased. Johnson and Bustin (2006) indicated that the largest fraction of coal dust studied (>2.36 mm) settled in seawater at a rate of 10.54 cm/s. This range of settling velocities and the results of atmospheric dispersion models was used to determine the magnitude of potential dispersion by water currents in the LAA. Atmospheric coal dust deposition is anticipated to be highest south of the Donkin Peninsula in the vicinity of the barge load-out facility. The water currents in this area were measured by Stantec in 2011 and modeled in the marine study conducted by CBCL (2012). The results indicate that current velocities in the vicinity of the barge load-out facility range from 0.05 to 15 cm/s in water depths of approximately 7 m. This suggests that, without the effects of upwelling and assuming consistent current direction, the largest fraction of coal dust would horizontally disperse in the marine environment approximately 0.3 m to 9 m, with the smallest coal fraction dispersing 18 m to 525 m. Based on the expected location of coal dust deposition in the lee of the breakwater of the barge load-out facility, the actual dispersal in the marine environment is anticipated to approach the shorter distances and less than dispersal by the atmosphere.

Benthic flora and fauna are likely the most susceptible to environmental effects from coal dust because of eventual deposition on the substrate. The environmental effects on pelagic marine species, including larval stages, are less likely because of anticipated lower concentrations in the water column resulting from dilution and mixing effects. The long-term interaction of coal dust with the substrate may create anoxic conditions and smother benthic organisms. A report by Johnson and Bustin (2006) on a marine coal handling facility on the west coast indicated that no anoxic conditions were observed within close proximity to the coal loading facility (0 - 300 m) during monitoring after 22 years of operation. Similarly, coal in marine sediments alongside a coal loading wharf in Australia in operation for 21 years indicated that effects on marine life were limited to an area directly below the loading chute adjacent to the wharf face, which resulted in localized changes to the benthic fauna assemblage due to changes in sediment texture (WBM Oceanics Australia 2006). Therefore the potential for widespread environmental effects from coal and coal dust on the marine environment is very low. The coal exposed from the local cliff-faces is continually eroded by natural ocean forces and contributes to the overall sediment loading to the nearshore marine environment. It is likely that any residual loss of coal from the Project will represent only a small fraction of coal and other erosional material naturally deposited around the Donkin Peninsula.

Construction of the barge load-out facility, installation of the transshipment mooring and the operation of marine loading and transportation are anticipated to affect ambient sound levels in the Marine Environment. To understand the environmental effects of Project-generated sound on marine habitats, it is important to describe existing, background sound levels in the Marine Environment. Generally, increases in low frequency sound levels (<1,000 Hz) affect marine habitat more than higher frequency sound levels. As such, the discussion on sound levels will focus on frequencies lower than 1,000 Hz.

At close proximity, these sounds have the potential to result in permanent threshold shifts (PTS); temporary threshold shifts (TTS); behavioural avoidance; and auditory masking

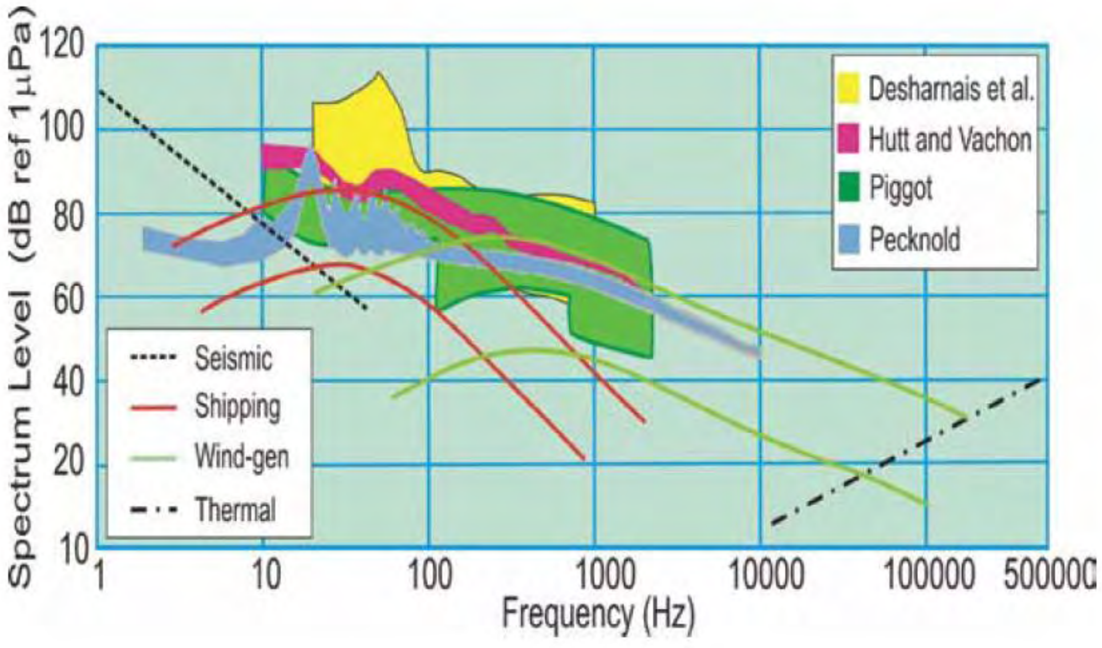
(Richardson *et al*. 1995; Nowacek *et al.* 2004). Each of these changes may compromise fish feeding efficiency, predator detection, and/or migratory success, and lead to reduced health and possibly death (Richardson *et al*. 1995).

PTS occur when high-intensity sounds cause irreversible physiological injury to the auditory tissues (Ward 1997; Southall *et al.* 2007). Depending on the level of exposure, PTS may represent partial or total hearing loss (Ward 1997; Southall *et al.* 2007). By comparison, TTS, also commonly referred to as auditory fatigue, does not involve physiological injury (Ward 1997; Southall *et al.* 2007). TTS occur when sounds of sufficient intensity and/or duration cause a temporary increase in the absolute auditory threshold (Ward 1997; Southall *et al*. 2007). TTS may last for several seconds to several minutes depending on the source level (Ward 1997; Southall *et al*. 2007).

Four data sets from the measurement of ambient marine acoustic noise levels conducted in the area surrounding the Scotian Shelf were utilized to create Figure 5.7.13. These data sets were chosen based on the abundance and proximity to the Project location. The four data sets include: Pigott (1964), using data collected in 1959/1960; Zakarauskas (1990), using data collected from 1972-1985; Desharnais and Collison (2001), using data collected in 1998; Hutt and Vachon (2004), using data collected in 2002; and Pecknold *et al*. (2010), using data collected in 2009.

Figure 5.7.13 illustrates the frequency and magnitude of marine sound levels in the ambient environment at various locations around the Scotia Shelf. In addition to the measured marine sound levels, this figure illustrates the predicted sound levels caused by noise generated by the wind on the surface of the ocean (‘wind-gen’) as well as the upper and lower ranges of the predicted noise contribution of marine shipping. The contribution of shipping-generated sound levels within the RAA would be closer to the lower range displayed in Figure 5.7.13.

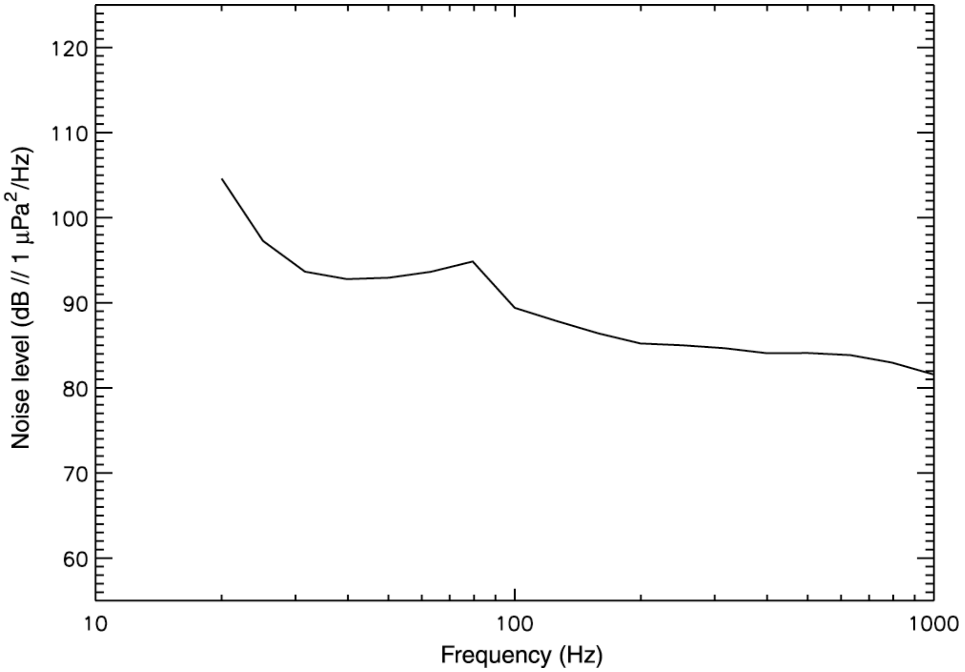
Figure 5.7.13 Scotian Shelf Ambient Marine Acoustic Sound Levels



Ocean Noise: State of the Scotian Shelf, Walsmley, undated

In another study (Collision 2001), sound levels within the Laurentian Channel were measured during a 2-hour period on December 2, 1998 with the sonobuoys deployed at a depth of 30 m (Figure 5.7.14). The approximately 95 dB re 1 µPa^2 peak in the 80-90 Hz range is due to shipping noise, with the 105 dB re 1 µPa^2 at the 20 Hz peak likely due to humpback whales in the area (Collision 2001). At the time of the survey, no ships were located within 75 nautical miles of the sonobuoy deployment and therefore represent conditions expected within the RAA. The noise levels in the upper frequencies around 1000 Hz were 81.6 dB re 1 µPa^2; these levels are within 3 dB of the levels predicted by Piggott for wind-generated noise as illustrated in Figure 5.7.13.

Figure 5.7.14 Laurentian Channel Ambient Marine Sound Levels



Collision (2001)

Throughout the Project, a variety of vessels will contribute sound to the Marine Environment. During construction of the barge load-out facility, tugboats, barges, and supply vessels will operate within the PDA. During operation, tugs and barges will transport raw coal to the transshipment mooring and large bulk carriers will transport raw coal from the transshipment mooring. It is anticipated that 14-39 bulk carriers of various sizes will use the transshipment mooring each year. These bulk carriers will be supplied by approximately 675 round trips by tugs and barges. The number of bulk carriers used by the Project will be determined based on the using either Cape Size Vessels (14 vessels required per year) or Panamax Size Vessels (39 vessels per year) or a combination of the two.

The majority of sound produced by an operating vessel is generated by propeller cavitation, the creation and collapse of high-pressure voids or bubbles (Ross 1987). Propulsion machinery and hydraulic flow over the hull also generate vessel sound emissions (Hildebrand 2003). In general, the source level of ship sound emissions increases with ship size, speed, propeller blade size, number of blades, and rotations per minute (Ross 1976; Gray and Greeley 1980; Scrimger and Heitmeyer 1991; Richardson *et al*. 1995; Hamson 1997).

Broadband sound levels created by the movement of vessels of various sizes are listed in Table 5.7.18. These broadband sound levels include the sound pressures at all frequencies and therefore are elevated in respect to the sound levels observed at specific frequencies.

Table 5.7.18 Broadband Sound Levels from Various Vessels at a Distance of 1 m.

Vessel	Vessel Activity	Speed	Broadband Sound Level (dB re 1 µPa @ 1 m)	Dominant Fequency (Hz)
Tug	Pushing/Pulling	Slow	193	1,000
Tug	Transiting	Half-speed	185	1,000
Bulk Carrier (173 m length)	Transiting	Full-speed	192	6 – 41
Bulk Carrier (223 m length)	Transiting	Half-speed	185	6 - 41
Fishing Vessel (17 m length)	Transiting	Half-speed	150	250 – 1,000

Table Adapted from JASCO Research (2008) and Hildebrand (2003)

Studies on the increase in marine sound levels from infilling could not be identified. It is anticipated that similar noise levels would result from dredging operations. Therefore comparisons to marine dredging operations will be utilized. Dredging operations in the marine environment create noise levels approximating 160 – 180 dB re 1 µPa at a distance of 1 m from the source with peak frequencies between 50 and 500Hz (Hildebrand 2003).

Behavioural responses to increased sound levels may include swimming away from the sound source which could result in leaving a primary feeding or spawning area (Popper 2003). Altering these behaviors could affect long-term behavior patterns, reproductive success and survival. Alternatively, loud noises could result in the fish “freezing” and staying in place which could leave the animal open to further hearing damage (Popper 2003). Hearing damage can increase risk of predation and alter reproduction or feeding behaviours (Laughlin 2005). In general, measurable harm to fish starts at exposure levels of approximately 190 dB re 1 µPa rms for 1 hour, with hearing being the most sensitive physiological element (Hastings and Popper 2005, Hastings *et al.* 1996). Enger (1981) showed that Atlantic cod (*Gadus morhua*) sustained damage to ear hair cells when continuously exposed to 180 dB µPa rms for 1 to 5 hours.

Harbour porpoises are also known to be relatively sensitive to vessel sound emissions, exhibiting local avoidance behaviour (Richardson *et al.* 1995). In a study comparing harbour porpoise distribution with vessel traffic density in the German North Sea, Herr *et al.* (2005) found a statistically significant negative correlation. Based on these findings, it is expected that harbour porpoises will exhibit localized avoidance of construction works in the PDA. However, because the PDA does not represent important foraging habitat for harbour porpoises, it is unlikely that localized avoidance of this area will affect harbour porpoise health.

It is unlikely that sounds produced during the construction of the barge load-out facility will mask sounds produced by either the harbour seal or the harbour porpoise. The harbour seal generally produces sounds only during courtship and breeding (Hangii and Schusterman 1994; Ralls *et al.* 1985). As there are no known seal breeding or pupping sites in the PDA (see Section 5.7.2.8), auditory masking of harbour seal sounds is unlikely. The harbour porpoises produce sounds in the range of 2 to 150 kHz (Mohl and Andersen 1973). These sounds are much higher in frequency than those associated with construction activities, making auditory masking unlikely.

Behavioural studies suggest that harbour porpoises are more reactive to sounds from construction activities than harbour seals (Koschinski *et al.* 2003; Henriksen *et al.* 2004; Tougaard *et al.* 2004; Herr *et al.* 2005). For example, Henriksen *et al.* (2004) reported decreases in harbour porpoise activity during construction of an offshore wind farm in the Danish Baltic Sea. In another study, Tougaard *et al.* 2004 investigated harbour porpoise activity during construction works similar to those of the Project. During periods of construction, the harbour porpoise spent less time foraging and displayed reduced acoustic activity compared to periods of no construction. These differences were observed at distances of up to 15 km from the site of construction. Activity of the harbour porpoises resumed to normal levels several hours after the completion of construction activities (Tougaard *et al.* 2004).

Like other baleen whales, the North Atlantic right whale is most sensitive to sounds below 1 kHz (Richardson *et al.* 1995; Nowacek *et al.* 2007; Southall *et al.* 2007). Morphometric analyses of inner ears from 13 stranded right whales indicate a functional hearing range of 15 Hz to 18 kHz (Parks *et al.* 2007). Given the low-frequency hearing sensitivity of the North Atlantic right whale, sounds produced by construction and bulk carriers will be audible to these whales. Although few studies have investigated the reactions of the right whale to approaching vessels, existing research suggests that the right whale exhibits very limited avoidance behaviour (Mayo and Marx 1990; Terhune and Verboom 1999; Nowacek *et al.* 2004). For example, Nowacek *et al.* 2004 exposed right whales in the Bay of Fundy to recorded sounds of passing vessels and observed no avoidance behaviour. Actual vessels transiting within 1.85 km (one nautical mile) of these whales also elicited no avoidance response. Other studies have reported observations of right whales turning directly into the paths of approaching vessels (Mayo and Marx 1990; Terhune and Verboom 1999). Collectively, these studies suggest that right whales are not highly reactive to approaching vessels, possibly because they are habituated to the sounds of vessels (Nowacek *et al.* 2004). Based on the existing literature, it is unlikely that acoustic emissions from the proposed increase in bulk carrier traffic will displace right whales from their migration route.

To ship the desired quantity of raw coal there is a requirement to load 39 Panamax size vessels, 14 larger Cape size vessels or a combination of the two. Under favorable weather conditions it is expected that a round trip of a tug and barge from the barge load-out facility to the transshipment mooring would take approximately 4 hours resulting in approximately 7 round trips daily (CBCL 2012). Using this timeframe the loading of a Panamax size vessel is anticipated to take 3 – 4 days and the loading of a larger Cape size vessel would take 8 to 10 days. Based on this loading rate, increased vessel traffic in Morien Bay would be present between 112 and 156 days per year. The RAA is within 22 km of the eastern seaboard shipping lanes and 4.5 km from local shipping lanes which provides access through the Cabot Strait to the Saint Lawrence River and local ports, respectively. These shipping lanes are anticipated to increase the ambient marine sound levels in the RAA.

Acoustic emissions from activities associated with the Project are not likely to induce auditory injury (PTS) or auditory fatigue (TTS) in any species of marine mammal within the LAA or RAA. With the exception of a tug working to move a barge and a full-speed bulk carrier that may harm marine animals in close proximity, the remainder of the vessels and construction sound levels are anticipated to fall below the levels at which measurable harm is shown to affect fish and incite possible behavioral responses. In particular, marine construction activities with high, impulsive sound emissions (*e.g.*, marine blasting or pile driving) are not proposed for the Project. As noted in Table 5.7.18 the produced sound levels are defined at a distance of 1 m from the source and are thus considered very conservative with respect to risk to marine species. Attenuation with the seafloor and air-water interface along with dissipation will cause a reduction of these levels with distance from the source, therefore the spatial extent of increased sound levels on the marine environment are anticipated to be localized to within the LAA during construction and operation and maintenance. A small number of harbour seals and harbour porpoises may be locally displaced from areas within the LAA during construction of the barge load-out facility. However, because the LAA does not represent important foraging or breeding habitat for either species, localized behavioral avoidance is not likely to adversely affect the health of these marine mammals. In summary, there may be limited behavioural effects experienced by fish and marine mammals within the PDA due to noise-producing activities during Project construction and operation and maintenance (*e.g.*, dredging/infilling and vessel operation). It is expected that these effects (*e.g.*, avoidance behavior) will be localized and intermittent, although they will persist for the duration of the Project.

In addition to increased noise levels, bulk carriers can introduce marine species into the RAA through ballast water exchange. Marine invasive species can be a threat to biological productivity, biodiversity, and commercial and recreational fisheries in the Marine Environment. Although no invasive species were noted during the marine benthic habitat assessments conducted by Stantec in 2011, the green crab (*Carcinus maenus*) occurs in the RAA and along the eastern shore of Nova Scotia. From a review of the relevant literature, no invasive species are known to occur within the LAA. However, there are invasive species with potential to establish within the LAA, given their occurrence in similar habitats along the east coast of Canada and the United States. The invasive species of particular concern are the lace bryozoan, oyster thief, Asian shore crab and the tunicate, *Didemnum* species. These species could eventually spread into the LAA by natural reproduction and distribution. The lace bryozoan (*Membranipora membranacea*) has devastated entire kelp beds in the Gulf of Maine. They are found on the coast of Maine, New Hampshire, and the south coast of Nova Scotia. Oyster thief (*Codium fragile* spp. *tomentosoides*), also known as Japanese sputnik weed or dead man's fingers, is a green algae that has been introduced through shellfish aquaculture, boating, and fouling on ship hulls. It occurs in Maine, and the south coast of Nova Scotia. Asian shore crab (*Hemigrapsus sanguineous*) is present in Maine and is considered likely to spread to Southern Nova Scotia. The tunicate (*Didemnum* spp.) is a colonial sea squirt that covers a wide variety of substrates and materials. It is found in coastal Maine and Massachusetts and in Georges Bank, and is rapidly expanding along the East Coast.

In 2000, the Shipping Federation of Canada introduced the Canadian Ballast Water Management Guidelines. These guidelines are intended to apply to all vessels entering Canada's exclusive economic zone, including those arriving from US ports. These guidelines were developed by Transport Canada and DFO under the auspices of the Canadian Marine Advisory Council, and as such, reflect wide consultation with groups such as ship owners, environmental organizations, various government departments, and the US Coast Guard. Ships travelling to and from the PDA will fall under Annex V of these guidelines: "Ballast Water Procedures for Vessels Proceeding to Ports on the East Coast of Canada". The annex states that the delineation of suitable alternative ballast water exchange zones and the determination of possible exemptions are subject to scientific studies and consultation with the appropriate scientific authorities. Any dumping of ballast water is to be conducted in accordance with the *Ballast Water Control and Management Regulations* under the *Canada Shipping Act*, *2001,* which include measures to protect against harmful aquatic organisms and pathogens. All vessels must comply with these regulations as part of normal operations. These regulations are specific as to the requirement for vessels to have exchanged or to treat ballast water to be discharged into the marine environment.

Vessels used for the Project will be required to have a Ballast Water Control Management Plan that establishes safe and effective procedures for ballast water management. The Ballast Water Control Management Plans are inspected and enforced by Transport Canada for compliance with the regulations during compliance visits. Under the regulations, ships must take one of the following measures to minimize discharge of harmful organisms to Canadian waters as well as to minimize the uptake of organisms that may be unintentionally released elsewhere:

- Exchange of ballast water outside the Exclusive Economic Zone for transoceanic navigation (*i.e.*, at least 200 nautical miles from land) and in water depth of over 2 000 m), and for non-transoceanic navigation at least 50 nautical miles from shore where the water depth is at least 500 m;
- Treatment of ballast water;
- Discharge of ballast water to an appropriately licensed receiving and treatment facility; and
- Retention of ballast water on board the ship.

Failure to comply with these measures will make the pumping of the ballast an offence. A record of the ballast management procedures undertaken is required to be maintained aboard all vessels. A requirement is in place for vessels to carry and implement a Ballast Water Management Plan. The plan must include the logging of the events of taking on ballast, exchanging ballast, and pumping ballast. These events are required to be reported to the

Minister of Transport on an approved form. Implementation of this plan and compliance with the regulations will reduce the risk of introduction of invasive marine species associated with ballast water discharge in the LAA.

Bilge water is regulated under the Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals. Under these regulations ocean going ships wishing to discharge bilge water containing oil or grease must be fitted with 15 ppm limit oil filtering equipment and a 15 ppm bilge alarm. Internationally, bilge water is regulated under Annex IV of MARPOL (IMO 1978/2004). Under this Annex, the discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or is discharging comminuted (pulverized) and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; or is discharging sewage that is not comminuted or disinfected at a distance of more than 12 nautical miles from the nearest land.

Although the introduction of an invasive species from the exchange of ballast water or discharge of bilge water could result in an adverse environmental effect on the Marine Environment within the PDA and LAA, the mitigation measures in place to reduce this risk is substantial. With planned compliance, the potential for introduction of invasive species in the Marine Environment is very low.

Conceptual Fish Habitat Compensation Plan

As a result of the infilling in the Marine Environment and the destruction of benthic fish habitat in the footprint of the barge load-out facility, the Project will require DFO authorization for the HADD of fish habitat prior to conducting infilling operations. To compensate for the direct loss of benthic habitat, the Project will be required to create new habitat (or improve existing habitat) to meet DFO's policy of no net loss under the *Fisheries Act*. The type and area of habitat to be created/enhanced will be detailed in a Habitat Compensation Agreement signed by both the Project and DFO. The specifications of the HADD compensation program will depend on the type of habitat compensation employed and assessed ecological value of existing habitat at the proposed infill site (refer to Section 5.7.2.4.3 for more information on the benthic habitat at the barge load-out facility). A conceptual fish habitat compensation plan for the HADD is presented in Appendix G.

Marine benthic habitat colonization has been shown to occur shortly after introduction of anthropogenic structures such as armour stone and caissons/cribwork in the marine environment (Pister 2009). Marine seaweeds, which are important components of lobster and other commercially valuable marine organism habitat, will also quickly colonize the hard substrate of in-water structures. Complete colonization of the armour stone and caissons of the barge load-out facility is expected to occur 2 to 3 years after the completion of construction; this timeframe is based on observations in the region from various projects. In a recent study, granite armour stone was compared to the natural rocky sandstone shoreline habitat in coastal waters and results indicate that species diversity and composition is similar once colonization occurs (Pister 2009). The armour stone of the breakwater will provide benthic habitat for lobster, crab, sea urchin and many other marine species and will create a diverse ecological community similar to that observed on boulders in the existing marine environment of the PDA. The colonization of the anthropogenic structures will attract other mobile species (*e.g.,* fish) for feeding and refuge, ultimately creating a “reef effect”, with similar biodiversity as in the natural marine environment. The armour stone will be layered with smaller stones under the main armour layer (Figure 2.4.3) which could also provide habitat for a range of lobster sizes, including juvenile lobsters, as well as fish species of varying lengths. The vertical timber cribwork or concrete wall of the caissons will also create new fish habitat by providing a hard substrate for marine organisms to attach to. The attachment of the marine organisms to the vertical structures will also likely attract free-swimming species providing foraging opportunities as well as shelter. The placement of anchors on the seafloor to stabilize the barge swing circle and transshipment mooring will initially disrupt marine benthic habitat, but then these anchors and mooring chains will be become surfaces for the colonization of marine organisms and habitat creation similar to the armour stone. At the transshipment facility, the four anchors will simulate the rocky habitat observed in the surrounding area, creating like-for-like habitat. At the transshipment mooring location the substrate was entirely composed of silty sand and the addition of four anchors will increase the potential attachment area for algal species, tunicates, sponges, bryozoans, hydroids and other species which inhabit reef-type habitats. The colonization of these structures is anticipated to improve habitat characteristics and colonization is expected to occur shortly after introduction of the anthropogenic structures to the marine environment.

Table 5.7.19 provides a summary of the surface area of marine habitat lost from the installation of marine-based infrastructure and the creation of new habitat through the placement of armour stone, caissons/cribwork and anchors, along with the resulting net change in the quantity of marine habitat. The alteration or destruction of benthic habitat is anticipated to be restricted to the PDA and which will be permanent and likely irreversible except for the removable components of the moorings.

Table 5.7.19 Total Area of HADD for the Marine-Based Infrastructure Associated with the Project

Marine-Based Infrastructure	Reduction in Quantity of Marine Habitat from Construction (m^2)		Increase in Quantity of Marine Habitat from Construction (m^2)		Net Gain(+)/ Loss (-) of Benthic Marine Habitat (m^2)	Net Gain(+)/ Loss (-) of Vertical Marine Habitat (m^2)	Total Gain(+) /Loss (-) of Marine Habitat (m^2)
	Project Task	Area	Project Task	Area			
Breakwater Structure	Infilling breakwater footprint	42,062	Breakwater Surfaces (Armour Stone)	11,804	-30,258	0	-30,258
Wharf Structure	Placement of Caisson/ Construction of Cribwork	4,385	Caisson/cribwork surfaces	1,450	-4,385	+1,450	-2,935
Barge Swing Circle	Placement of Anchors	55	Anchor Surfaces	55	0	0	0
Cumulative Total for the Barge Load-out Facility	**All tasks**	**46,502**	**All Tasks**	**13,309**	**-34,643**	**+1,450**	**-33,193**
Transshipment Mooring Location	Placement of Anchors	55	Anchor Surfaces	55	0	0	0

5.7.4.2 Assessment of Change in Mortality Risk

5.7.4.2.1 Potential Environmental Effects

The risk of mortality to fish may be increased through the construction of the barge load-out facility and the installation of the transshipment mooring anchors. Construction of the marine-based infrastructure (breakwater and load-out wharf) may increase mortality risk even with the application of mitigation measures.

For the purposes of this discussion, “fish” is defined as marine and anadromous finfish and invertebrates. The potential for fish mortality due to construction of the barge load-out facility (*i.e.,* placement of armour stone, installation of caissons/cribwork, and placement of anchors) and installation of the transshipment mooring (*i.e.,* placement of anchors) is ranked as 2 in Table 5.7.17 and requires further assessment below.

Infilling for the construction of the breakwater, placement of the caissons for the wharf and placement of anchor systems for the moorings may result in the loss of fish. Sessile or slow moving demersal fish or invertebrates will likely be unable to avoid construction activities within the footprint of marine infrastructure and will suffer mortality as a result of smothering or crushing. Using similar reasoning, installation of anchors to support the transshipment mooring may result in the mortality of sessile or slow moving demersal fish or invertebrates.

Coal or coal dust may be deposited in the Marine Environment and which could potentially affect mortality risk or health of fish and invertebrates.

The change in the ambient marine sound levels caused by construction of the barge load-out facility and increased vessel traffic during operation is unlikely to increase fish mortality. In general, lethal conditions result from trauma to other organs and tissues in the range of 200 dB re 1 µPa and greater (Turnpenny and Nedwell 1994). Furthermore, studies have shown that high levels of ambient sound can result in reduced egg survival and reduced reproductive and growth rates in aquaculture species (Smith *et al*. 2004; Banner and Hyatt 1973; Lagardere 1982).

As discussed in Section 5.7.2.2 the RAA may provide habitat for 26 fish species of special status, including those most likely to occur in the PDA: Atlantic cod; Atlantic salmon; and striped bass. It is unlikely that individuals of these 26 species of special status will suffer mortalities as a result of project construction or operation and maintenance. The species of special status all represent mobile finfish species, marine mammals and sea turtles and as such it is anticipated that these species will avoid construction areas due to the associated noise.

The possibility of ship strikes on marine mammals and sea turtles is low as a result of the Project. Once bulk vessels leave the shipping channel in the Gulf of St. Lawrence, they will reduce their speed enroute to the transshipment location and decrease their speed even further to be assisted by tug boats and to attach to the single buoy mooring. The reduction in speed of the vessels will mitigate and minimize the possibility of striking a whale or sea turtle and thus minimize mortality risk.

5.7.4.2.2 Mitigation of Project Environmental Effects

Mitigation of environmental effects on increased mortality risk with the construction of the barge load-out wharf and transshipment location include:

- Geotechnical/Engineering investigations into wharf and breakwater construction methods to reduce the quantity of materials placed in the marine environment.
- The contractor will be required to use fill material for the breakwater to be free of fines, debris and any substances that would be deleterious to the marine environment.
- Compliance with stipulations in in the *Fisheries Act* authorizations for HADD and Section 32 approval.
- Vessels will travel at reduced speeds near the barge load-out facility, the transshipment facility and points between which will reduce potential for strikes on marine mammals and marine reptiles.

5.7.4.2.3 Characterization of Residual Project Environmental Effects

Mobile pelagic and demersal finfish will likely avoid construction activities due to the associated noise and therefore direct mortality will be low; however, sessile or slow moving demersal fish and invertebrates will likely be unable to avoid construction activities within the footprint of marine infrastructure and will suffer mortality as a result of smothering or crushing.

It is not anticipated that any coal or coal dust deposited in the Marine Environment during operation and maintenance will have a direct environmental effect and increase the mortality risk or health of fish and invertebrates. Spillage of coal during barge loading and offloading on bulk vessels and release of coal dust into the atmosphere will be mitigated through a variety of control measures (Section 2.7.6). Chemicals of concern are not expected to be released into the Marine Environment, except through potential accidental spills (addressed in Section 6). No marine outfall is anticipated during the operation of the Project beyond the current discharge of treated mine water monitored through regular fish toxicity testing. Mined coal, which is carbon and one of the source materials used for making activated carbon for uses in spill cleanup, groundwater remediation, drinking water filtration and air purification, is not a chemical of concern in its raw form. As described previously, trace metals from raw coal is not easily released into seawater and only the trace metals manganese, nickel and zinc may be leached and measureable in seawater. Furthermore, any coal that will be present in the Marine Environment will be limited to the PDA and therefore the environmental effects on mortality risk, if any, will be low.

Underwater sound emissions from Project activities are not anticipated to increase fish mortality. Turnpenny and Nedwell (1994) summarized the following physiological environmental effects of sound on fish:

- Transient stunning at 192 dB re 1 µPa;
- Internal injuries at 200 dB re 1 µPa;
- Egg/larval damage at 220 dB re 1 µPa; and
- Fish mortality at 230-240 dB re 1 µPa

The anticipated underwater sound pressure levels as described in Table 5.7.18 range from 185 to 193 dB re 1 µPa at a distance of one metre. Therefore the radiated noise levels will be somewhat less and, hence, no physiological effects are expected on adult, juvenile or eggs and larvae of commercial or non-commercial finfish species from Project-generated sound in the PDA, LAA and RAA.

5.7.4.3 Summary of Project Residual Environmental Effects

Table 5.7.20 summarizes the residual environmental effects of the Project on the Marine Environment.

Table 5.7.20 Summary of Project Residual Environmental Effects: Marine Environment

Project Phase	Mitigation/Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		
Change in Marine Habitat										
Construction	• Geotechnical/Engineering investigations for barge construction methods to reduce the quantity of materials placed in the marine environment (*i.e.*, marine footprint). • Authorization of HADD and fish habitat compensation project to offset the net loss of productive capacity due to the footprint of the barge load-out facility. • The contractor will be required to use fill material for the breakwater to be free of fines, debris and any substances that would be deleterious to the marine environment. • Barges will have appropriate freeboard design and efficient material handling to reduce product losses to the environment (*i.e.*, no barge overloading, avoiding	A	L	L	P	O	R	U	N	• Marine Sediment Sampling Program to monitor sediment chemistry in the PDA during initial stages of operation. • Marine Benthic Habitat Program to monitor colonization by marine benthic organisms of subtidal marine infrastructure during initial stages of operation, including fish habitat compensation project.

Table 5.7.20 Summary of Project Residual Environmental Effects: Marine Environment

Project Phase	Mitigation/Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		
Operation and Maintenance	transiting in high sea states). • Project vessels will comply with all applicable legislation, codes and standards of practice for shipping, including the *Ballast Water Control and Management Regulations* under the *Shipping Act* to reduce risk of introduction of marine invasive species. • Vessels will travel at reduced speeds near the barge load-out facility, the transshipment facility and points between which will reduce underwater noise.	A	L	L	LT	R	R	D	N	

Table 5.7.20 Summary of Project Residual Environmental Effects: Marine Environment

Project Phase	Mitigation/Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		
Change in Mortality Risk										
Construction	• Geotechnical/Engineering investigations into barge construction methods to reduce the quantity of materials placed in the marine environment (*i.e.*, marine footprint). • The contractor will be required to use fill material for the breakwater to be free of fines, debris and any substances that would be deleterious to the marine environment. • Compliance with stipulations in in the *Fisheries Act* authorizations for HADD and Section 32 approval. • Vessels will travel at reduced speeds near the barge load-out facility, the transshipment facility and points between which will reduce potential for strikes on marine mammals and marine reptiles.	A	M	S	ST	O	I	U	N	
Operation and Maintenance		A	L	S	LT	R	I	D	N	

Table 5.7.20 Summary of Project Residual Environmental Effects: Marine Environment

Project Phase	Mitigation/Compensation Measures	Direction	Residual Environmental Effects Characteristics						Significance	Recommended Follow-up and Monitoring
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context		

KEY

Direction:

P	Positive: condition is improving compared to baseline habitat quality or population status
N	Neutral: no change compared to baseline habitat quality or population status
A	Adverse: negative change compared to baseline habitat quality or population status

Magnitude:

L	Low: measurable effects to habitat function anticipated in low-sensitivity habitats and no measurable reduction in number of any marine species anticipated
M	Moderate: measurable effects to habitat function anticipated in moderately sensitive habitats or anticipated mortality risk to non-listed species
H	High: measurable effects to habitat function anticipated in highly sensitive habitat or habitat designated as important for listed species or anticipated mortality risk to listed species

Geographic Extent:

S	Site: effects restricted to habitat within the PDA
L	Local: effects extend beyond PDA but remain within the LAA
R	Regional: effects extend into the RAA

Duration:

ST	Short term: effects are measurable for days to a few months
MT	Medium term: effects are measurable for many months to two years
LT	Long term: effects are measurable for multiple years but are not permanent
P	Permanent: effects are permanent

Frequency:

O	Once: effect occurs once
S	Sporadic: effect occurs more than once at irregular intervals
R	Regular: effect occurs on a regular basis and at regular intervals
C	Continuous: effect occurs continuously

Reversibility:

R	Reversible: effects will cease during or after the Project is complete
I	Irreversible: effects will persist after the life of the Project, even after habitat restoration and compensation

Environmental Context:

U	Undisturbed: effect takes place in an area that has not been adversely affected by human development
D	Disturbed: effect takes place in an area that has been previously adversely affected by human development or in an area where human development is still present
N/A	Not Applicable

Significance:

S	Significant
N	Not Significant

5.7.5 Assessment of Cumulative Environmental Effects

In association with the Project environmental effects discussed in the previous sections, an assessment of the potential cumulative environmental effects was conducted for other projects and activities that have potential to interact with the Project. Table 5.7.21 identifies the potential for overlap between the Project activities and cumulative environmental effects of other projects and activities conducted or to be conducted in the RAA. Table 5.7.21 ranks each interaction with other projects as 0, 1, or 2 with respect to the nature and degree to which important Project-related environmental effects overlap with those of other projects and activities.

Table 5.7.21 Potential Cumulative Environmental Effects to Marine Environment

Other Projects and Activities with Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects	
	Change in Marine Habitat	Change in Mortality Risk
Commercial Fishing Operations	1	2
Maritime Link	1	1
Port of Sydney Development	2	2

KEY

0 = Project environmental effects do not act cumulatively with those of other projects and activities.
1 = Project environmental effects act cumulatively with those of other projects and activities, but the resulting cumulative effects are unlikely to exceed acceptable levels with the application of best management or codified practices.
2 = Project environmental effects act cumulatively with those of other projects and activities and the resulting cumulative effects may exceed acceptable levels without implementation of project-specific or regional mitigation.

The Maritime Link Project is located outside the spatial boundaries of the RAA and as such it is not anticipated to contribute to the cumulative environmental effects on the Change in Marine Habitat and Change to Mortality Risk for the Marine Environment. Therefore it is ranked a 1 and no further assessment would be necessary. The Port of Sydney Development (*i.e.*, channel dredging and infilling) will cumulatively act on the marine habitat within the RAA. The dredging activities will harmfully alter, disrupt or destroy marine habitat. The Sydney Harbour Channel dredging and infilling received Section 32 and HADD authorizations and have completed HADD compensation projects (artificial reefs) in Sydney Harbour. The cumulative effect results from the temporary loss of marine habitat post-dredging and prior to the re-colonization of the dredged area and to the implementation of the fish habitat compensation project.

Commercial fishing operations within the LAA have historically fished species (lobster and crab) using stationary gear (traps). This method of fishing within the LAA is expected to continue into the future and produces no change in marine habitats. Commercial fishing methods within the RAA vary from use of stationary gear (for lobster and crab) to use of mobile gear for groundfish operations. Trawling is the predominant method of fishing for groundfish within the RAA (DFO

2002, cited in Schaefer *et al*. 2004). This method of fishing has the potential to produce a change in marine habitat. Trawling operates under the principle of dragging a net along or just above the seafloor with select species being retained and based on the size of the mesh.in the net. This can change the marine habitat through the direct interaction of the gear and the seafloor. The fishing industry follows several best management practices to reduce the impact of trawling on sensitive benthic habitats. These practices include:

- Modifications to trawl doors that will reduce pressure on the seafloor.
- Use of discs or bobbins along the bottom cable to raise it off the seafloor or by off-bottom rigging of the lower bridle reducing the frequency and duration of impacts to the seafloor.
- Reduction of pressure on the seafloor through the use of lighter gear components and gear components with lifting capabilities.
- Reduction of the bottom area that is directly affected by trawl doors can be achieved with the use of high aspect ratio doors and by reducing the shoe angle relative to the towing direction.
- Reduction in the affected area by sweeps/bridles through the use of shorter bridles, reduced sweep/bridle angle and by discs and bobbins mounted along the length of the wires.

In summary, modifications to mobile gear include reduction of the length of the ground gear and arrangements that reduce the number of contact points between the gear and the bottom (FAO 2007).

Commercial fisheries will cumulatively change the mortality risk within the LAA and RAA. Historically commercial fisheries have added to the decrease in fish populations and in some cases to endangered levels (COSEWIC 2010a, COSEWIC 2010b). Commercial fisheries continue to increase the mortality of target species, in addition to by-catch induced mortalities for non-target species. Mitigation for commercial fisheries include; limited licensing, regulated seasons, size limits, quota limits and best management practices for the reduction of bycatch. The seasons, size and quota limits for commercial fish are determined through scientific publications and studies and represent to the best available knowledge the amount of biomass that can be sustainably removed from the environment. Best management practices to reduce bycatch include alteration of the panel size of the trawl net, and the panel is sized to allow the efficient capture of appropriately sized target species while allowing undersized and smaller species to pass through the net. Additional mitigation measures include Turtle Exclusion Devices (TEDs), Bycatch Reduction Devices (BRDs) and various other deflectors that are being used in select fisheries.

The dredging for the Port of Sydney Development will cumulatively change the mortality risk within the RAA. Mobile pelagic and demersal finfishes will likely avoid construction activities from these projects due to the associated noise and direct mortality will be low; however, sessile or slow moving demersal fish and invertebrates will likely be unable to avoid construction activities within the dredge and infill area and will likely suffer mortality as a result of crushing or smothering. Approval for Project-induced fish mortality is authorized under Section 32 of the *Fisheries Act*. Fish mortality caused by Project construction will be an extremely small cumulative contribution to the mortality caused by the commercial fishery.

5.7.6 Determination of Significance

Initially, the construction phase of the Project will result in a net loss of productivity of the marine benthic habitat in the PDA through the infilling required for the barge load-out facility and the installation of the transshipment mooring. Increased ambient marine sound levels from construction may initially serve to reduce the mortality risk in the LAA from infilling but elevated noise levels may result in habitat avoidance during the remainder of the construction period in the LAA. During operation of the barge load-out facility an undetermined amount of product coal may be deposited in the Marine Environment through the loading and unloading processes at both the barge load-out facility and the transshipment mooring. This product coal may alter the chemical composition of the substrate through the leaching of metals, specifically manganese. To mitigate the habitat altered during the construction of the Project, the Project will obtain authorization for the Harmful Alteration, Disruption or Destruction (HADD) of fish habitat prior to conducting infilling operations. To compensate for the direct loss of benthic habitat**,** the Project will be required to create new habitat (or improve existing habitat) to meet DFO's policy of no net loss under the *Fisheries Act*. The type and area of habitat to be created/enhanced will be detailed in a Habitat Compensation Agreement.

The characterization of the potential adverse environmental effects combined with the proposed mitigation measures, indicate that the residual adverse environmental effects of a change in marine habitat during all phases on the Marine Environment are rated not significant.

Increased mortality among sessile organisms will occur during construction of the barge load-out facility and the installation of the transshipment mooring; this will take place only after approval by DFO. No changes in mortality risk are anticipated for the Marine Environment during operation and maintenance or decommissioning and reclamation. The residual adverse environmental effects of a change in mortality risk as a result of the environmental effects of the Project during all phases on the Marine Environment is rated not significant. The sessile species observed (green sea urchins, starfish, periwinkles) within the PDA were noted as common to abundant and the reduction of individuals within the PDA is not likely to result in a significant effect on the marine populations such that natural recruitment would not re-establish the species to its original composition, density and extent in one generation.

The conclusions of the cumulative effects assessment with respect to changes to marine habitat and mortality risk considering Project related effects overlapping with the same effects from other projects and activities has been rated as not significant after application of mitigation measures and required habitat compensation programs.

In summary, Project and cumulative residual environmental effects on the Marine Environment from a change in marine habitat or a change in mortality risk are predicted to be not significant.

5.7.7 Follow-up and Monitoring

The following monitoring programs will be designed and implemented according to applicable permitting, regulations and scientific methods with input from local regulators, notably DFO and EC.

- A Marine Sediment Sampling Program to monitor the sediment chemistry within the PDA during the initial stages of operation. This would confirm EA prediction of spillage of coal and coal dust. Continuation of this monitoring would be based on the initial monitoring results.
- A Marine Benthic Habitat Monitoring Program to monitor the colonization by marine benthic organisms of the intertidal and subtidal marine infrastructure, and specifically the breakwater, during initial stages of operation.
- A Marine Benthic Habitat Monitoring Program to monitor the biological activity surrounding the HADD fish habitat compensation project to document viability of artificial habitats. This program will likely be run concurrently with the program to monitor the colonization of the subtidal marine infrastructure.

5.8 COMMERCIAL AND RECREATIONAL FISHERIES

Commercial fisheries are important to the local and regional economy and traditions. The marine components of the Project will interact with local inshore fisheries around the Donkin Peninsula and into Mira Bay. Commercial and recreational fisheries is considered a VEC due to interactions with the Project, regulatory protection of fish and fish habitat, the importance of the fishery to the region, and stakeholder concerns. The EIS Guidelines require the EIS to address potential Project interactions with inshore commercial fisheries and aquaculture.

The assessment of Commercial and Recreational Fisheries considers potential routine Project interactions with local commercial and recreational fisheries, with a focus on interactions of marine construction and operations with local inshore commercial fisheries. Due to limited interaction with recreational fisheries (according to stakeholder accounts, there is no organized recreational fishery in the marine environment, some angling occurs in freshwater systems in the community), the VEC will focus on marine commercial fisheries.

This VEC is closely linked to the assessment of Marine Environment (Section 5.7) and Current Use of Lands and Resources for Traditional Purposes by the Mi’kmaq of Nova Scotia (Section 5.10). Potential biological effects on marine commercial fish species and freshwater fish species are addressed in Marine Environment (Section 5.7) and Freshwater Fish and Fish Habitat (Section 5.6), respectively.