Environmental Impact Statement

Long Harbour Commercial Nickel Processing Plant
Volume 2.
Effects Assessment - Biophysical Environment

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1.0 Introduction

This volume describes the existing biophysical environment and presents the effects assessment for biophysical Valued Ecosystem Components (VECs). The Existing Environment section provides perspective on the regional and local environments and summarizes relevant data useful for the prediction of effects. In large measure, the first chapter in this volume draws on, and provides a summary review of, the Component Studies prepared and submitted for Government review as per the EIS Guidelines. The Component Studies form part of this EIS and should be referred to where a more detailed description of the existing biophysical environment is sought.

Each section under Existing Environment describes the regional setting followed by the local environmental setting at the Project site. Three study areas that have been defined for this EIS.

- Terrestrial Environment – general area within a 10 km radius of the Project site
- Atmospheric and Freshwater Environment – airshed and waterbodies within a 10 km radius
- Marine Environment – Placentia Bay with emphasis on the eastern side and Long Harbour.

The second part of Volume 2 contains the effects assessments on the VECs. This part of the EIS contains the prediction of effects for the Construction, Operations, and Decommissioning Phases of the Project, the effects of potential accidents, and the cumulative effects of the Project in combination with other planned and ongoing activities.

The major sections of this volume present the assessments of identified VECs as established by the EIS Guidelines and confirmed through VBNC consultations. Particular attention has been paid to accidental events because of their potential to result in significant effects. However, it is notable that the corporate target is to achieve zero unplanned discharges to the environment. Wherever helpful, VBNC has employed modeling to predict the fate and effects of any planned discharges. These tools are a valuable means to identify patterns and provide feedback to ongoing design, however by nature they produce conservative projections.

2.0 Existing Environment

Placentia Bay is a diverse and productive ecosystem that has been of economic, social, and cultural importance to humans for centuries. It contains large seabird colonies of international significance, relatively large populations of bald eagles and river otters, a number of Atlantic salmon rivers, as well as important human enterprises such as the commercial fisheries (including aquaculture), an oil refinery and transshipment terminal, shipyards, ports, and tourism facilities. This ecosystem is composed of a number of inter-related physical, chemical, biological, and human components.

Information on this ecosystem was gathered from the libraries of Memorial University, Fisheries and Oceans Canada, and those of the various consultants who prepared this document. In addition, VBNC conducted a number of original Component and supporting studies.

- Air Quality (SENES 2007a, 2007b)
- Terrestrial Environment (JWL 2007)
- Freshwater Environment (AMEC 2007a)
- Marine Environment (LGL 2007)
- Ecological and Human Health Risk Assessment (Intrinsik 2007)

These studies were prepared by specialist consultants on behalf of VBNC. The Component Studies were subjected to detailed Government and public review and formal acceptance as comprising baseline description documents which provide information to assist in the prediction of environmental effects. The specialist technical studies provided necessary input to, and support for , the predictive statements made with respect to anticipated environmental effects.

2.1 Atmospheric Environment

The Project site is a predominantly rural area located on the southwestern portion of the Avalon Peninsula, on the east side of Placentia Bay. The closest industrial activities within Placentia Bay include the CVRD Inco Limited Demonstration Plant at Argentia, the Come by Chance oil refinery, Newfoundland Transshipment Terminal, CN Ferry Terminal, Port of Argentia, the Marystown Shipyard, the Cow Head Fabrication Facility, and commercial fisheries and associated processing plants.

Ambient monitoring data obtained from Newfoundland Department of Environment and Conservation describe the existing environment in the vicinity of the Project Area (B. Lawrence, pers. comm.). All the data described in this section are from monitoring stations in close proximity to a known emission source. Since there are no significant emission sources near to the proposed Project, the actual baseline concentrations there are expected to be lower than any of the reported data.

2.1.1 Particulate Matter (PM10 and PM2.5)

Table 2.1 summarizes measurements of airborne particulate matter with a mass medium diameter < 2.5 microns ($PM_{2.5}$) at two monitoring stations at the Argentia CVRD Inco Limited Demonstration Plant, and three monitoring stations operated by North Atlantic Refining Limited (NARL). There is only one station (NARL) that collects PM_{10} (< 10 microns) data.

Table 2.1 Measured Concentrations of $PM_{2.5}/PM_{10}$ (µg/m^3)

Station	Approximate Distance and Direction from Site	Data Period	Averaging Time			
			Annual (µg/m^3)	24-hour (µg/m^3)		
				Maximum	90th Percentile	98th Percentile
Argentia – Runway	17 km southwest	Oct-05- Oct-06	2.8	20.9	6.1	11.0
Argentia – Roadway	17 km southwest	Oct-05- Oct-06	2.4	14.2	5.1	8.5
NARL – Tricentia	40 km northwest	Jan-02 – Jan-05	5.5	62.9	8.1	11.8
NARL - Come by Chance	50 km northwest	Jan-02 – Jan-05	5.4	52.2	8.2	11.7
NARL – Gardner $PM_{2.5}$	50 km northwest	Jan-02 – Jan-05	5.2	60.4	8.1	11.4
NARL - Gardner PM_{10}	50 km northwest	Jan-02 – Jan-05	7.3	69.9	11.7	16.8
Key: NARL - North Atlantic Refining Limited.						

PM levels in the atmosphere are a function of both natural and anthropogenic sources. 'Background' PM is generally defined as the distribution of PM concentrations observed in the absence of anthropogenic emissions including precursor emissions of VOC, NO_x and SO_2. The actual magnitude of background PM for a given location is difficult to determine, because of the influence of long-range transport of anthropogenic particles and precursors. The range of expected background concentrations on an annual or long-term basis is from 4 to 11 µg/m^3 for PM_{10} and 1 to 5 µg/m^3 for $PM_{2.5}$ for remote sites in North America (Health Canada 1998).

The annual average $PM_{2.5}$ concentrations from the CVRD Inco Limited Argentia Demonstration Plant, and the PM_{10} concentration from the North Atlantic Refining Limited (NARL-Gardner) site fit within this range of typical rural concentrations.

The average annual PM_{10} concentration measured at the NARL-Gardner site is also in the range of measurements made in 1998 at three monitoring locations in Argentia (NewfoundKnowledge Inc. 1999).

- Water Reservoir 4.7 µg/m^3
- Pearce Peak 4.2 µg/m^3
- Fox Harbour 6.7 µg/m^3

Based on this data, it is estimated that the background concentration of PM_{10} is in the order of 5 µg/m^3. The average one-hour concentrations over one year of measurements at the CVRD Inco Limited Argentia Demonstration Plant suggest that the background concentrations at the Project site are in the order of 2.5 µg/m^3. This level is also in agreement with data from monitoring sites across Canada that show that approximately 50% of PM_{10} is made up of $PM_{2.5}$.

2.1.2 Nitrogen Dioxide (NO_2)

The closest monitoring stations that measure NO_2 are located approximately 50 km east of the Project site. These five stations are operated by Newfoundland and Labrador Hydro, and the available data is limited to one or two months in 2005.

The average annual ambient NO_2 concentrations range from 1.8 to 2.8 µg/m^3 at locations close to potential sources (Table 2.2). Due to the lack of significant proximate sources of NO_2, the average background concentration of NO_2 is anticipated to be less than 2 µg/m^3 at Long Harbour.

Table 2.2 Measured Concentrations of NO_2 (µg/m^3)

Station	Distance and Direction from Site	Data Period	Averaging Time			
			Annual (µg/m^3)	24-hour (µg/m^3)		
				Maximum	90th Percentile	98th Percentile
NL Hydro – Butterpot	Approximately 50 km east	Feb-05	2.8	7.4	4.7	6.6
NL Hydro - Green Acres		Feb-05	2.5	7.2	4.0	6.9
NL Hydro – MAAMS		Jan-05, Feb-05	1.8	7.3	3.3	5.3
NL Hydro - Indian Pond		Feb-05	2.5	8.2	4.3	7.2
NL Hydro - Lawrence Pond		Jan-05, Feb-05	2.0	6.3	3.9	5.1

Key: NL Hydro – Newfoundland and Labrador Hydro.
NARL - North Atlantic Refining Limited.

2.1.3 Sulphur Dioxide (SO2)

SO_2 monitoring data are available for several locations to the northwest, and to the east of the Project site. The annual average SO_2 concentrations range from 3 to 8 µg/m^3 (Table 2.3).

For comparison, NewfoundKnowledge Inc. (1999) reports annual average (1998) SO_2 concentrations for three sites in Argentia.

- Water Reservoir 0.4 µg/m^3
- Pearce Peak 0.6 µg/m^3
- Fox Harbour 3.4 µg/m3

Table 2.3 Measured Concentrations of SO_2 (µg/m^3)

Station	Distance and Direction from Site	Data Period	Averaging Time			
			Annual (µg/m^3)	24-hour (µg/m^3)		
				Maximum	90th Percentile	98th Percentile
NL Hydro - Butterpot	Approximately 50 km east	Jan-02-Jan-04	3.0	44.5	43.2	44.4
NL Hydro - Green Acres			3.8	68.1	48.6	65.5
NL Hydro - Indian Pond			5.6	251.1	110.9	235.9
NL Hydro - Lawrence Pond			7.3	111.5	67.1	88.0
NARL - Tricentia	40 km northwest		3.2	166.2	158.9	164.7
NARL - Come by Chance	50 km northwest		7.1	86.6	54.6	77.3
NARL - Gardner	50 km northwest		8.2	94.2	62.3	76.0

Key: NL Hydro – Newfoundland and Labrador Hydro.
NARL - North Atlantic Refining Limited.

Overall, the SO_2 concentrations recorded at all three sites were low, with the exception of occasional elevated levels associated with activities at the Come By Chance Refinery. The higher annual average concentration at Fox Harbour may be due to local sources such as wood stoves, vehicle traffic or fumes from fishing vessels (NewfoundKnowledge Inc. 1999).

Based on the range of data presented above, the background SO_2 concentration in the vicinity of the Project site is anticipated to be on the order of 3 µg/m^3.

2.1.4 Existing Noise Levels

At present, there are no measured sound level data (historical or recent) for the Long Harbour area (E. Dwyer, VBNC, pers. comm.). Long Harbour is a predominantly rural area. The closest residences to the Project site are located about 0.5 km away, on the north side of the harbour. Ambient sound levels are probably typical of a small coastal community, i.e., relatively low with the possible exception of the demolition works and scrap metal site described below. Local vehicle and boat traffic likely compose most of the background sound.

Historically, Long Harbour was an active area and would have routinely been subject to industrial noise. The lower site (the VBNC Tier 1) and surrounding area was used from 1969 to 1989 by Albright and Wilson Americas Limited (AWA),and was decommissioned in the mid-1990s.

Long Harbour Development Corporation has subleased its portion of the site to Marex Inc., which has been demolishing the unused facilities. Newco Metals, a scrap metal dealer, also operates at the site, barging scrap from the existing wharf, which Marek Inc. has also used to receive salt for distribution around the province. The company also conducts boat repair activities intermittently throughout the year. Canadian Coast Guard vessels also dock at the wharf. The site has also seen some incidental offshore oil supply vessel traffic in recent years related to storage of drilling fluids.

Other industrial activities within Placentia Bay add little to the background sound levels at Long Harbour.

2.2 Terrestrial Environment

The western Avalon Peninsula is an area of rolling uplands interspersed with small plateaus at elevations ranging up to 300 m above sea level (masl). The influence of bedrock geology on local physiography is highlighted by the numerous northeast to north-northeast aligned coastal fjords, coinciding with the axis of major folds and faults (NLDNR 2002). Erosional and striation data suggest that an independent ice sheet occupied the Avalon Peninsula, with the main ice dome located at the head of St. Mary's Bay and smaller ice fields located near Collier Bay Brook, just north of Long Harbour. It is likely that this ice remained until approximately 9000 BP. Surface features of the area have been crafted by these glacial and erosional events, which have left a blanket of till, of varying thickness and composition, over the Project site (Batterson and Taylor 2003).

2.2.1 Geology and Soils

The western Avalon Peninsula lies with the Avalon Tectonostratigraphic zone and forms the eastern extent of the Northern Appalachians, with bedrock consisting mainly of Pre-Cambrian igneous and sedimentary rocks, overlain by Paleozoic shallow-marine, terrestrial sedimentary, and minor volcanic rocks (King 1988). In the Long Harbour area, subaerial sedimentary rocks, consisting of sandstones, siltstones, and conglomerate (Musgravetown Group) are intruded by Devonian granitic rocks composed mostly of fine to medium-grained diorite, gabbro, and granite.

Till, commonly occurring as a veneer over bedrock and present throughout the western Avalon, is poorly consolidated, very poorly sorted with a silty-sand matrix. Near Long Harbour the approximate thickness of till is 3m. Glaciofluvial sand and gravel are found in the Project site, although this sediment is commonly thin.

Soils of the western Avalon Peninsula are predominantly podzolic in nature, formed from the glacial and glaciofluvial tills and sediments, which blanket the Project site. Organic soils occur in depressions and areas of impeded drainage. Mineral soils of the area tend to be strongly acidic (pH less that 4.5) with very low buffering capacity, reflecting the nature of the parent material from which they were derived. A combination of low fertility, moderate precipitation, and a cool climate has resulted in shallow soil profiles, with moderately well defined horizons. For the same reasons, productivity of the soils is poor, with no agricultural potential, and low potential for commercial forestry. Organic matter levels in mineral soils range from 0.5 to 8% in surface horizons (Heringa 1981).

Baseline studies (JWL 2007a) have shown that soil chemical characteristics are within the ranges of values normally expected for similar soils in North America (Kabata-Pendias and Pendias 2001), being relatively high in iron and aluminum. High levels of manganese have been observed in some locations, and are attributable to surface exposure of manganiferous rocks. Elevated levels of cobalt, selenium, and copper have also been noted at a few sampling sites (JWL 2007a). Soils in the immediate Project site consist predominantly of acidic humo-ferric podzols of the Fair Haven and Bauline series (Heringa 1981). These soils have developed from stony and moderately coarse-textured till derived from siltstone, slate, sandstone, and granitic rocks. Depending on local topography, soils range from imperfectly drained to well-drained. Bedrock outcrops are common, and surface soils tend to be excessively stony. Soil profile development tends to be somewhat restricted by a cool climate and recalcitrant soil parent material.

The soils near Long Harbour are nutrient-poor, and are classified predominantly as Class 7, with no capability for agriculture due to restrictions of steep topography, exposure of bedrock, and stoniness (Heringa 1981).

2.2.2 Vegetation

The Project site is located within the Southeastern Barrens Subregion of the Maritime Barrens Ecoregion of Newfoundland (Damman 1983). Prior to European settlement, mixed forest stands dominated the Southeastern Barrens Subregion. Intentional and accidental fires combined with the slow growing conditions have since altered the vegetation of the Subregion to extensive areas of heathland barrens and exposed rock. Balsam fir stands are now largely restricted to smaller patches, often in sheltered valleys and on steep slopes. Slope bogs and basin bogs are more common than fens and are scattered throughout the area.

The heathland barrens are dominated by low shrub species, such as crowberry, sheep laurel, Labrador tea, blueberry, and leatherleaf as well as stunted larch, black spruce, and balsam fir. The forest stands are dominated by balsam fir with lesser amounts of black spruce. White birch, when present, forms a minor component in the canopy layer. Typical shrub species include willow (*Salix* spp.), Labrador tea, squashberry, and red-osier dogwood. Bunchberry and creeping snowberry, twinflower, and corn lily often dominate the herb layer.

The wetlands are typically nutrient poor. Typical dominant species include sphagnum moss, bakeapple, bunchberry, and pitcher plant, with minor amounts of sedges and grasses.

Project Area

Field investigations (JWL 2007b) indicate that there are six general vegetation community types in and around the Project Area (Figure 2.1). The Project footprint (comprising the two combined options, hydromet and matte) is indicated in brown on Figure 2.1 and the area surveyed is outlined in yellow.

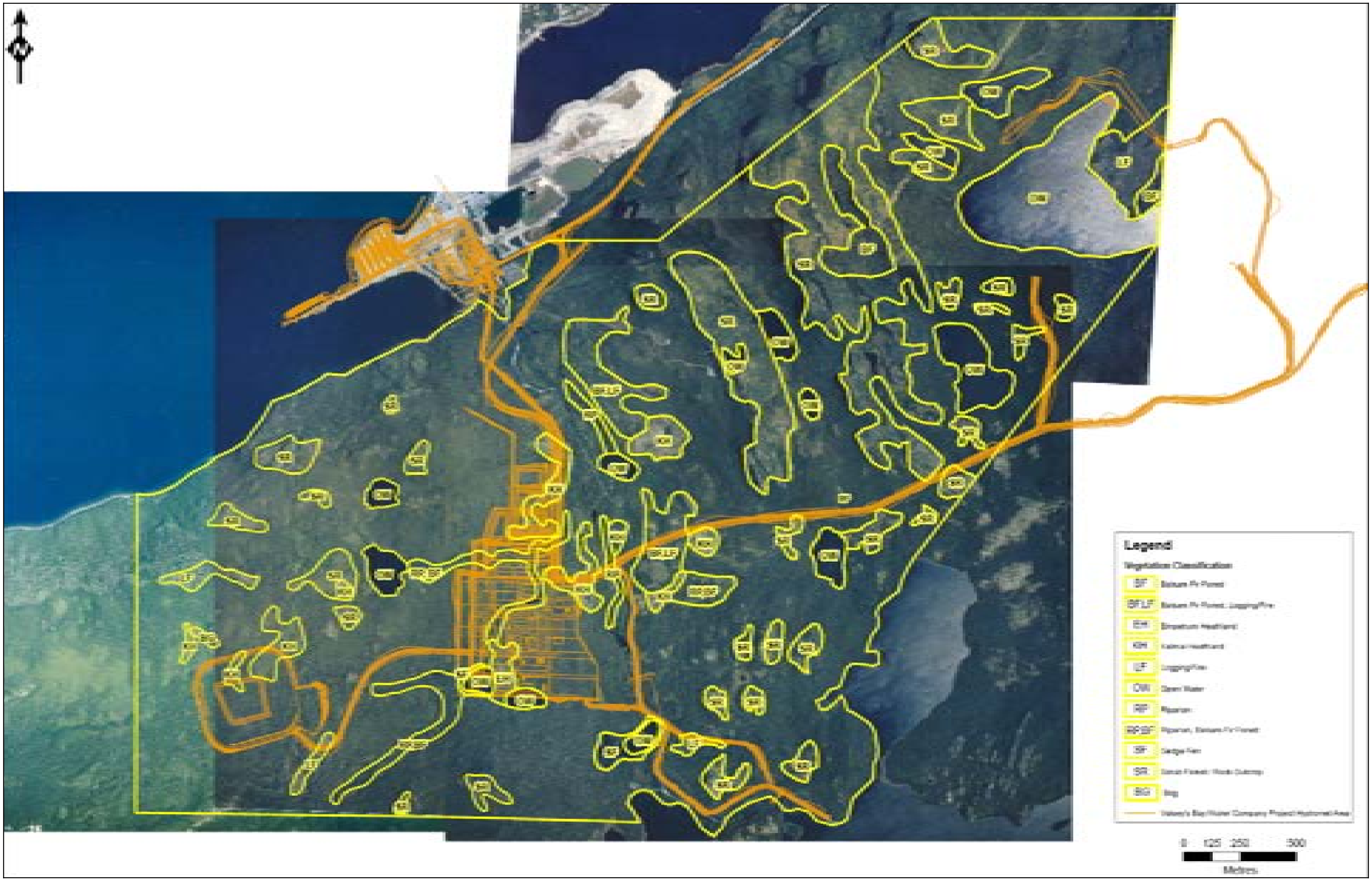


Figure 2.1 Vegetation Communities

The vegetation community areas are shown in Table 2.4 and the common and scientific names of the plants are listed in Table 2.5.

Balsam fir forests (BF) cover 762 ha of the area surveyed and dominate the survey area. This forest cover comprises mainly balsam fir with lesser amounts of black spruce and birch within the tree layer. Kalmia, Labrador tea, young balsam fir, and black spruce dominate the shrub layer when present. Typical herb species include creeping snowberry and bunchberry. The moss layer is largely comprised of red-stemmed feather moss, knight's plume, and step moss. Parent material, slope position, and moisture regime vary throughout the range of the community, which has resulted in a variable composition from near-scrub forest to open mature succession stands.

Scrub Forest/Rock Outcrop (SR) units are scattered throughout the area and are situated on the crest and upper slopes of the rock outcrops. Soils, when present, are shallow and rapidly drained. The trees within this unit are stunted and limited in size to shrubs on the more exposed areas. Species include balsam fir and black spruce with lesser amounts of larch. Vegetative cover ranges from moderate to non-existent, and when present, include common juniper, kalmia, crowberry, reindeer lichen, and mosses.

Wetlands were classified according to the Canadian Wetland Classification System (National Wetlands Working Group 1997). Three wetlands, all classed as floating (sedge) fens (SF), cover approximately 3.17 ha of the total area surveyed, and are largely restricted to the southwestern section. Only two SF units were large enough to map at the scale of 1: 12,500. Other units were observed during the field surveys, but were isolated and generally less than 200 m^2 or forming narrow fringes around shallow ponds. Typical species within this herbaceous community include bluejoint, sedges, bulrushes, bog aster, and violets. Floating pondweed is a common aquatic submergent species.

Table 2.4 Vegetation Community Areas for the Project Area

Vegetation Community Type	Map Label	Total Area (ha)	Area within Footprint (ha)
Open Water	(OW)	64.03	2.46
Sphagnum Bog	(BG)	0.45	0.00
Sedge Fen (wetlands)	(SF)	3.17	0.78
Empetrum Heathland	(EH)	2.45	2.24
Kalmia Heathland	(KH)	20.07	7.14
Scrub Forest / Rock Outcrop	(SR)	118.49	0.30
Complex of Riparian and Balsam Fir Forest	(RP, BF)	15.03	3.92
Logged / Burned / Cleared	(LF)	13.62	1.01
Balsam Fir Forest	(BF)	762.13	80.88
Riparian	(RP)	3.30	0.14
Complex of Balsam Fir Forest and Logged / Burned / Cleared Forest	(BF, LF)	17.56	0.69
Total		**1,020.31**	**99.55**

Table 2.5 Common and Scientific Names of Plants Found in the Project Area

Tree Layer		Herb Layer (continued)	
Balsam fir	*Abies balsamea* > 4 m	Northern bedstraw	*Galium boreale*
Mountain white birch	*Betula cordifolia* > 4 m	Creeping snowberry	*Gaultheria hispidula*
American larch (tamarack)	*Larix laricina* > 4 m	Oak fern	*Gymnocarpium dryopteris*
Black spruce	*Picea mariana* > 4 m	Dwarf rattlesnake plantain	*Goodyera repens*
Shrub Layer		Hawkweed	*Hieracium sp.*
Chuckley-pears	*Amelanchier spp.*	Canadian rush	*Juncus canadensis*
Alder	*Alnus rugosa*	Rush	*Juncus spp.*
Balsam fir	*Abies balsamea* <4 m	Bog laurel	*Kalmia polifolia*
Mountain white birch	*Betula cordifolia* <4 m	Twinflower	*Linnea borealis*
Leather leaf	*Chamaedaphne calyculata*	Heart-leaved twayblade	*Listera cordata*
Red-osier dogwood	*Cornus stolonifera*	Canada mayflower	*Maianthemum canadense*
Larch / Tamarack	*Larix laricina* < 4 m	One-flowered wintergreen	*Moneses uniflora*
Labrador tea	*Rhododendron groenlandicum*	Indian pipe	*Monotropa uniflora*
Common juniper	*Juniperus communis*	Sidebells wintergreen	*Orthilia secunda*
Sheep laurel (kalmia)	*Kalmia angustifolia*	Lesser round-leaved orchid	*Platanthera orbiculata*
Sweetgale	*Myrica gale*	Ribbonleaf pondweed	*Potamogeton natans*
Mountain holly	*Nemopanthus mucronatus*	Tall buttercup	*Ranunculus acris*
Black spruce	*Picea mariana* < 4 m	Bakeapple	*Rubus chamaemorus*
Choke cherry	*Prunus virginiana* subsp. *virginiana*	Dwarf raspberry	*Rubus pubescens*
Skunk currant	*Ribes glandulosum*	Pitcher plant	*Sarracenia purpurea*
Red raspberry	*Rubus idaeus*	Panicled bulrush	*Scirpus microcarpus*
Willow	*Salix spp.*	Rough-stemmed goldenrod	*Solidago rugosa*
Northern mountain ash	*Sorbus decora*	Spirea	*Spirea latifolia*
Northern wild-raisin	*Virburnum cassinoides*	Tall meadowrue	*Thalictrum pubescens*
		Starflower	*Trientalis borealis*
Herb Layer		Horned bladderwort	*Utricularia cornuta*
Rough bentgrass	*Agrostis scabra*	Lowbush blueberry	*Vaccinium angustifolium*
Purple-stemmed aster	*Aster puniceus*	Violet	*Viola sp.*
Common ladyfern	*Athyrium filix-femina*	Partridgeberry	*Vaccinium vitis-idaea*
Bluejoint	*Calamagrostis canadensis*	Dwarf bilberry	*Vaccinium cespitosum*
Soft-leaf sedge	*Carex disperma*	**Bryophyte Layer**	
Sedge	*Carex* spp.	Reindeer lichen	*Cladina spp.*
Blue bead lily	*Clintonia borealis*	Broom moss	*Dicranum spp.*
Threeleaf goldthread	*Coptis trifolia*	Step moss	*Hylocomium splendens*
Bunchberry	*Cornus canadensis*	Red-stemmed feather moss	*Pleurozium schreberi*
Black crowberry	*Empetrum nigrum*	Knight's plume	*Ptilium crista-castrensis*
Fringed willowherb	*Epilobium ciliatum*	Racomitrium moss	*Racomitrium sp.*
Joe-pye weed	*Eupatorium maculatum*	Sphagnum moss	*Sphagnum spp.*

Much of the riparian habitat (RP) within the area surveyed has been disturbed due to the past channelling of Rattling Brook. As a result, the riparian habitat within the Project site is poorly defined and variable in vegetation composition and distribution. A smaller area of undisturbed riparian habitat, mapped as a complex with the surrounding BF, occurs sporadically along an unnamed stream to the west of Rattling Brook. Species observed in the shrub layer include red-osier dogwood, spirea, alder, and willow. Typical herbs include bluejoint, sedges, asters, and willow herbs.

The broader heathland barrens habitat is represented in the area surveyed by empetrum heathland (EH) and kalmia heathland (KH) variants and covers approximately 2 ha and 14 ha respectively. The EH community type is isolated to one site in the southern part of the survey area, although it is widespread in the South Eastern Barrens Subregion. This open, low shrub community is dominated by black crowberry, kalmia, bakeapple, and reindeer lichen. The KH is interspersed throughout the BF forming variable sized patches. This open low shrub community is drier than the EH community and is dominated in the shrub layer by kalmia, leather leaf, and Labrador tea. The herb layer is often sparsely vegetated, while the bryophyte layer is dominated by reindeer lichen and red-stemmed feather moss. Although not field checked, the sphagnum bog (BG) mapped on the western edge of the survey area is likely dominated by sphagnum peat moss. Vascular plants likely present in varying amounts include buckbean, bakeapple, crowberry, leather leaf, and bog aster. Minor amounts of sedges, rushes, and grass species may also be present.

Approximately 10 ha of the area surveyed has been disturbed recently by fire or logging activities, and is mapped as LF. These areas were observed to be typically comprised of a robust shrub layer of balsam fir, kalmia, and blueberries. Observed herb and bryophytes include crowberry, bunchberry, and reindeer lichen. These areas may either revert to forest community types or develop into heathland barrens as is typically the case in the Southeastern Barrens Subregion, and are not considered a stable vegetation community type.

2.2.3 Forest Resources

The forest surrounding Long Harbour is a source of uses, both consumptive (including wood harvesting, trapping, and hunting) and non-consumptive (such as recreation and aesthetic uses) (Department of Natural Resources 2006).

The area is used for domestic cutting, indicated by the presence of stumps and cutovers. Balsam Fir forest covers 75% of the 1020 ha comprising the area surveyed for vegetation in 2006 (JWL, 2007b). The reminder is largely scrub forest, heathland, and rock outcrop uplands. A modest portion of the forest is merchantable timber; however, accessibility is an issue due to the rough terrain and lack of access trails.

A portion of the Project site is located within Domestic Cutting Area H-5D (Rattling Brook) in Forest Management District 1 (Avalon Peninsula). One of the designated areas surrounds Sandy Pond (Figure

2.2). The Avalon forests are part of the larger boreal forest ecosystem and are dominated by balsam fir, black spruce, white birch, and larch.

The forests of the Avalon are primarily affected by harvesting, windthrow, and insects. Balsam fir forest types are stable (i.e., they naturally come back to the same forest type) following disturbance. Spruce types generally go to another spruce type following fire, but after cutting to a more open spruce type or heath in the absence of silvicultural treatment (Department of Natural Resources 2006). This was the site history of large portions of heathland in the Project Area. There was also evidence of insect damage (*Coleoptera* sp.) in some forested areas, and some windthrow and ice damage (JWL 2007b). These areas were small and isolated.

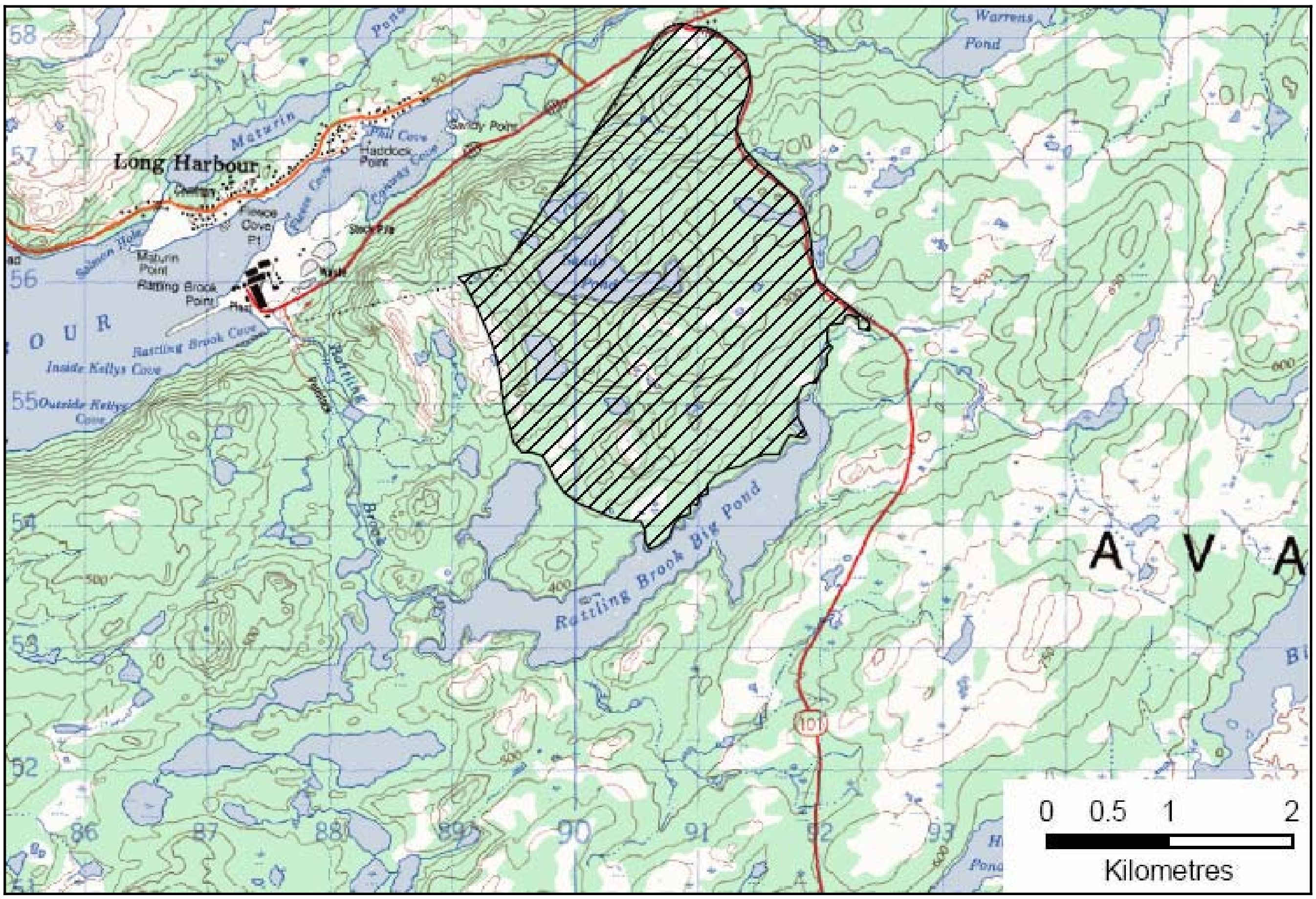


Figure 2.2 Location of Domestic Cutting Area H-5D (Rattling Brook) in Forest Management District 1

2.2.4 Terrestrial Avifauna

Approximately 120 species of avifauna breed, and over 340 species are known to occur, in insular Newfoundland. Recent surveys (JWL 2007b) indicate that at least 34 of these are known to use the Project Area that contains appropriate habitat for many species of terrestrial birds, particularly songbirds. Table 2.6 lists the species observed in and around the Project site and in the area of Long Harbour. Newfoundland generally shows a noticeable paucity of avifauna, relative to nearby Nova Scotia and Quebec (Peters and Burleigh 1951; Godfrey 1966). Approximately one-quarter of the species breeding in Nova Scotia do not breed in Newfoundland (Godfrey 1966). This relatively low diversity of terrestrial species is typical for an island, especially one with a relatively low diversity of habitats Habitat to support raptors and waterfowl is also considered limited.

Habitats such as the boreal forest, riparian zones, heaths, bogs, and upland scrub provide the nesting and foraging opportunities in this ecosystem. Migratory songbirds such as warblers, thrushes, sparrows, and flycatchers nest in the trees, shrubs, and grasses in the area, and feed on the abundant insects, invertebrates, and seeds. The ponds, rivers, and wetlands in the area provide some breeding and foraging habitat for waterfowl.

Ruffed grouse was observed in mixed-forest habitat in the Project site (JWL 2007b). It is likely that this species is using the area year-round as it has been reported previously (Albright & Wilson Americas 1992). Although no observations of spruce grouse were recorded, it is possible that this species also occurs in the area, given the amount of suitable boreal habitat present. Willow ptarmigan, although undetected on the surveys, may also use the area, specifically barren upland areas where windswept spruce would provide adequate cover.

Suitable habitat also exists for species of raptor to nest and/or hunt in the area. The following discussion of existing conditions considers their current state in and near the Project Area.

Raptors

Raptors (Order: *Falconiformes*) are diurnal, predatory birds that include osprey, eagles, falcons, hawks, and harriers. Diets of raptors range from insects and fish to large vertebrates and carrion. Most species breed in trees, on cliff ledges or in cavities (Gill 1990).

The raptors observed or expected in the area around Long Harbour comprise three Families: *Pandionidae* (osprey), *Accipitridae* (sharp-shinned hawk, northern goshawk, northern harrier, and bald eagle), and *Falconidae* (American kestrel and merlin). The osprey is a cosmopolitan species found around lakes and coasts around the world, feeding almost exclusively on fish (Chubbs and Trimper 1998; Poole et al. 2002). Ospreys have been previously observed in Long Harbour (Albright & Wilson Americas 1992).

Table 2.6 Species of Birds Observed or Heard in Long Harbour Survey Areas during Point Count Surveys 15 to 17 June 2006

Common Name	Scientific Name	Project site	Long Harbour
Ruffed Grouse	*Bonasa umbellus*	√	
Greater Yellowlegs	*Tringa melanoleuca*	√	
Wilson's Snipe	*Gallinago delicata*	√	
Herring Gull	*Larus argentatus*	√	
Greater Black-backed Gull	*Larus marinus*	√	
Belted Kingfisher	*Ceryle alcyon*		√
Downy Woodpecker	*Picoides pubescens*	√	
Black-backed Woodpecker	*Picoides arcticus*	√	
Northern Yellow-shafted Flicker	*Colaptes auratus*	√	√
Yellow-bellied Flycatcher	*Empidonax flaviventris*	√	
Alder Flycatcher	*Empidonax alnorum*	√	
Gray Jay	*Perisoreus canadensis*	√	
American Crow	*Corvus brachyrhynchos*		√
Common Raven	*Corvus corax*		√
Black-capped Chickadee	*Poecile atricapilla*	√	
Boreal Chickadee	*Poecile hudsonica*	√	
Red-breasted Nuthatch	*Sitta canadensis*		√
Golden-crowned Kinglet	*Regulus satrapa*		√
Ruby-crowned Kinglet	*Regulus calendula*	√	√
Swainson's Thrush	*Catharus ustulatus*	√	√
Hermit Thrush	*Catharus guttatus*	√	√
American Robin	*Turdus migratorius*	√	√
European Starling	*Sturnus vulgaris*		√
Yellow Warbler	*Dendroica petechia*	√	
Yellow-rumped Warbler	*Dendroica coronata*	√	√
Pine Warbler	*Dendroica pinus*	√	
Blackpoll Warbler	*Dendrioca striata*	√	√
Black and white Warbler	*Mniotilta varia*	√	√
Northern Waterthrush	*Seiurus noveboracensis*	√	√
Mourning Warbler	*Oporornis philadelphia*	√	√
Common Yellowthroat	*Geothylpis trichas*		√
Wilson's Warbler	*Wilsonia pusilla*	√	
Savannah Sparrow	*Passerculus sandwichensis*	√	√
Fox Sparrow	*Passerella iliaca*	√	√
Swamp Sparrow	*Melospiza georgiana*		√
White-throated Sparrow	*Zonotrichia albicollis*	√	√
Dark-eyed Junco	*Junco hyemalis*	√	√
Pine Grosbeak	*Pinicola enucleator*	√	√
Red Crossbill	*Loxia curvirostra*		√
White-winged Crossbill	*Loxia leucoptera*	√	
Pine Siskin	*Carduelis pinus*		√
American Goldfinch	*Carduelis tristis*		√

The sharp-shinned hawk is much smaller than the osprey, feeding on small mammals and even insects, although its diet is primarily small birds (Bildstein and Mayer 2000). The northern goshawk can take a variety of prey, including squirrels, hares, grouse, corvids, woodpeckers, and passerine birds (Squires and Reynolds 1997). Northern harriers forage on the wing, capturing a wide range of prey, mainly small- and medium-sized mammals, and birds (MacWhirter and Bildstein 1996). Harriers are mostly found around fields, barrens, and grasslands that are limited to some upland barrens within the Project site. The bald eagle (*Haliaeetus leucocepahlus*) is an opportunistic forager that eats a variety of mammalian, avian, and reptilian prey, but generally prefers fish to other food types (Buehler 2000). It typically breeds in forested areas adjacent to large bodies of water.

Bald eagles were observed during VBNC terrestrial surveys in 2006, and by residents during winter and less frequently during summer (JWL 2007b). No nest sites were detected during those surveys within or adjacent to the Project site. Directed surveys for bald eagle were conducted as part of the VBNC marine studies and additional detail is contained in the discussion of the marine environment.

Owls (Order: *Strigiformes*) are mainly nocturnal birds of prey that feed on small rodents, shrews, frogs, insects, and birds. Owls usually take over the nests of other birds, the burrows of mammals, or find natural cavities. Great horned, northern hawk, and short-eared owls are possibly present in the area, based on available habitat types (Birds of North America Online 2007). The great horned owl is a habitat generalist, breeding in forested habitats throughout the Island of Newfoundland; it has the most extensive range, the widest prey base, and the most variable nesting sites of any North American owl (Houston et al. 1998). The northern hawk owl is mainly diurnal and nests in dead tree stubs or woodpecker holes in open coniferous or mixed coniferous-deciduous forests, burned-over areas, or muskeg (Duncan and Duncan 1998). The short-eared owl is an open-country, ground-nesting species that inhabits marshes, grasslands, and tundra throughout much of North America (Wiggins et al. 2006). This species may occur in the area, but is not likely in the Project site, given the lack of suitable open country habitat.

Songbirds and Woodpeckers

The Project site provides habitat for songbirds and woodpeckers throughout most of the forested areas. The term songbird encompasses flycatchers, crows, warblers, vireos, sparrows, thrushes, wrens, nuthatches, swallows, chickadees, kinglets, grosbeaks, and blackbirds. Many of the species found in the area are migratory and present only during the breeding season, approximately June-September. These birds come to Newfoundland to exploit abundant seasonal food resources (i.e., insects) and raise their young. Some are neotropical migrants, coming from Central and South America, the Caribbean, and Mexico; these species include most of the warblers, thrushes, flycatchers, vireos, swallows, and blackbirds. Other species are temperate migrants, coming from the United States to breed and leaving in fall. These species include the ruby-crowned kinglet, sparrows, and the yellow-rumped warbler. Other species such as crows, nuthatches, chickadees, and grosbeaks are resident year-round in Newfoundland, and are able to exploit seed resources or have adaptations to help them through winter (e.g., food caching, bark gleaning). These species include: gray jays and common ravens, which employ food-caching and a varied diet to survive winter; black-capped and boreal chickadees, who can switch from insects to seeds; dark-eyed juncos, white-winged crossbills, pine grosbeaks, all seed specialists in winter; and the tiny insectivorous golden-crowned kinglet, which has adapted huddling techniques to survive the cold (Heinrich 2003); and some American robins have overwintered in recent years, surviving on berries.

The woodpecker species in the Project Area are all Newfoundland residents. The northern flicker and the downy woodpecker are confirmed in the area, and it is likely that hairy and black-backed woodpeckers are also present. They may supplement their winter diets by exploiting birdfeeders and suet.

From current data collected in 2006 (JWL 2007b), bird species richness varied from five to 22 according to habitat. The highest species richness occurred in mixed forest (balsam fir dominant) sites (22), followed by the burns/cuts (19), balsam fir/spruce (18), and riparian sites (17). The spruce (dry) sites had a richness of 11 over two sites, and the spruce (wet) site had a richness of 5. Birds are known to respond to habitat structure and composition, and since mixed forest provides the greatest variety of structure and composition, it supports the greatest number of bird species.

The most abundant species in the area surveyed in 2006 are typical of a migratory boreal forest songbird assemblage (JWL 2007b). Northern waterthrush and white-throated sparrow (occurring at essentially every survey point), plus blackpoll warbler, alder flycatcher, fox sparrow, and ruby-crowned kinglet are all highly associated with boreal forest habitat (Birds of North America Online 2007). These species would be expected to be in greater abundance than the rest of the observed species. Others recorded in abundance were generalist species such as the American robin and ellow-rumped warbler, which can exploit several types of forested habitat.

Waterfowl

Several species of waterfowl occur in Eastern Newfoundlan: American black duck (*Anas rubripes*), green-winged teal (*Anas crecca*), ring-necked duck (*Aythya collaris*), common goldeneye (*Bucephala calangula*), common merganser (*Mergus merganser*) and red-breasted merganser (*Mergus serrator*). However, only American black duck and green-winged teal were confirmed in the surveyed areas during 2006 (JWL 2007b). Twenty-six American black ducks were found in a small pond in the Rattling Brook Big Pond watershed during late winter (18 March 2006) and 23 were observed the following day (JWL 2007b). A single green-winged teal sighted during October 2006 surveys suggested that it was using the area as a stopover before continuing migration (JWL 2007b). Because its breeding areas are far from human activity, its numbers have remained high and are even increasing (Johnson 1995).

The most common duck species in the Project Area is the American black duck (*Anas rubripes*), a large dabbling duck that breeds in freshwater wetlands, brooks, lakes, ponds, and bogs throughout the boreal forest (Longcore et al. 2000).

The Long Harbour area displays rugged terrain with a mixture of boreal forest cover and peatlands. Beaver are abundant in the many lakes and ponds, and their impoundments enhance potential for use by waterfowl, notably black duck, (Longcore et al. 2000). Waterfowl nesting in Newfoundland are characterized by early-breeding (dabbling ducks and geese) and late-breeding (diving ducks and sea ducks). By mid to late July 2007, clutches of all species of waterfowl likely to nest on the survey area were hatched (notably black and ring-necked ducks).

Black duck, northern pintail (*Anas acuta*), green-winged teal, ring-necked duck, common merganser and common loon (*Gavia immer*) were confirmed as breeding in low densities in the survey area. No unusually large aggregations or uncommon species of waterfowl were located, and the area was typical of the general southeastern barrens ecodistrict. By late July to early August 2007, broods of dabbling ducks were mostly feathered and almost full grown, whereas diving ducks such as ring-necked duck were still in mid to late downy stages, and young common mergansers were partially feathered. Overall, the ring-necked was the most abundant duck species, and biologists detected adult males in eclipse plumage in early August 2007 on wetlands, indicating that some sites were used to complete the annual feather moult. This species is noted for the northward expansion of its breeding range over the past four decades and its exploitation of acidic wetlands, especially peatlands (Goudie 1987). The common loon was ubiquitous in the survey area, indicating that many lakes and ponds support healthy fish populations.

2.2.5 Wildlife

The terrain in and around the Project site provides habitat for 13 species of aquatic and terrestrial mammals. Several taxonomic Families are represented including: shrews, bats, hares, squirrels, beavers, mice, canids, weasels, cats, and deer. The boreal forest, riparian zones, heaths, bogs, and upland scrub provide different habitats for mammal species occupying different niches in the ecosystem. Some of these species are semi-migratory or occupy large home ranges, and others are more sedentary, occupying smaller areas. The ponds, rivers, and wetlands provide some breeding and foraging habitat for aquatic and semi-aquatic mammals like mink, beaver, muskrat, and otter. Suitable habitat also exists for several forest and open-country species. The following discussion provides a description of mammals that occur in or near the Project site.

Small Mammals

Several species of small mammals are known or expected from the Project site: the common (or masked) shrew (*Sorex cinereus*), introduced in the late 1950s; little brown bat (*Myotis lucifugus*); deer mouse (*Peromyscus maniculatus*); meadow vole (*Microtus pennsylvanicus*); house mouse (*Mus musculus*); and Norway rat (*Rattus norvegicus*) are possible, but the habitat is marginal to support these species.

The common shrew is the most widely distributed shrew in North America. They are found in damp forest habitats. Their diet consists primarily of worms, insects, and snails; they can eat their own body weight in a day. Shrews occur in the Project area (JWL 2007b).

The little brown bat is found throughout the Island of Newfoundland wherever there are trees, buildings, or caves. In summer, they roost in buildings or trees; in winter, they hibernate in frost-free locations such as caves, mineshafts, cellars, tunnels, or unoccupied buildings. Little brown bats feed on insects including moths, beetles, mosquitoes, and flies; during summer they consume about half their weight in insects each night, gaining the body fat needed to survive months of hibernation.

The deer mouse, occuring in forests and grasslands throughout Newfoundland, is the most widely distributed small native rodent in North America. Its diet consists of seeds, fruits, fungi, eggs, and larvae of insects and spiders.

The meadow vole inhabits forest habitat of Newfoundland and has been found at the Project site (JWL 2007). It inhabits wet meadows and open grassland near streams, lakes, ponds, and swamps eats mainly herbaceous vegetation, grasses, sedges, fruits, seeds, grain, and some snails and insects. In insular Newfoundland, this is the only native small mammal prey of carnivores.

Terrestrial Furbearers

Several species of terrestrial furbearers are known or likely to occur in and around the Project site. These include snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*), red fox (*Vulpes vulpes deletrix*), coyote (*Canis latrans*), ermine (*Mustela erminea*), and lynx (*Lynx canadensis subsolanis*).

Snowshoe hares, introduced to the Island around 1870, occur throughout most of the boreal forest in coniferous, deciduous or mixed habitat. They are a major prey item for carnivores and are considered by many to be a keystone species in the ecosystem, meaning they are crucial to the functioning of the ecosystem as it now exists. Predators that depend heavily on hare abundance include coyote, marten (*Martes americana*), red fox, lynx, ermine, great horned owl, and northern goshawk. Hares exhibit a 9-10 year population cycle (Boutin 1995). In spring and summer, they feed primarily in open areas on grasses and herbaceous plants; in winter, they strip bark from young trees or the new growth of woody plants. Evidence of snowshoe hare occurs in essentially all terrestrial habitats in the Project site, particularly where there is cover and adequate food (JWL 2007a).

The red squirrel is the most widely distributed squirrel in North America, generally associated with coniferous forest, but also found in mixed-wood and deciduous (Kemp and Keith 1970). They are important to the ecosystem as a prey item for many species like hawks, owls, coyotes, weasels, lynx, and marten. Squirrels are omnivorous and have a varied diet including seeds, nuts, berries, fungi, insects, bird eggs, juvenile animals (e.g., birds, rodents, and hares), carrion, and tree bark (Klugh 1927). Squirrels or their sign were regularly observed in Project site in 2006 (JWL 2007a).

The red fox is native to Newfoundland and is found across the island, mostly in semi-open habitats. Its generalist diet consists of small mammals (voles, squirrels, hares, and mice), nesting waterfowl, berries, plants, young birds, eggs, and trout (Environment Canada 2006). Sign of this species was often encountered along streams and new and old access trails during surveys in 2006 (JWL 2007a).

Coyotes were first confirmed on the Island in 1987, and according to sighting and trapping records, are now widely dispersed across the island. It is believed that coyotes made their way over on pack ice, and they were actually sighted coming ashore (Parker 1995). Wildlife officials have documented the expansion of coyotes in Newfoundland and are investigating their morphology, diet, age structure and reproductive rates (Government of Newfoundland and Labrador 2004). With the extinction in 1930 of the Newfoundland wolf, the coyote has become the top predator on the island.

Coyotes are generalists in their diet, feeding on small mammals, hare, caribou calves (and sometimes adults), moose calves, birds and eggs, insects, amphibians, and berries. The coyote is extremely adaptable and its continued population growth in Newfoundland has been controversial. Despite several eradication attempts throughout North America, coyotes have actually expanded their range (the litter size of a coyote increases with lower densities). In Newfoundland, as elsewhere, populations will likely be controlled more by the amount of available habitat more than by management programs. From trapping data, it is probable that the coyote population in and around the Project site is ‘very low’ (M. McGrath, pers. comm.).

Ermine (*Mustela erminea*) are primarily nocturnal hunters feeding on small mammals, hares, birds, insects, fish, frogs, carrion, and berries. Ermine prefer riparian forest, marsh, shrubby second-growth, and open areas adjacent to forests. Ermine were observed during surveys associated with the phosphorus plant decommissioning in 1991 (Albright & Wilson Americas 1992).

Lynx prefer old growth boreal forest, usually with thick cover and usually in areas where the snowshoe hare population has increased. The lynx winter diet consists 75% of snowshoe hare; thus the population cycles of the two species coincide. When prey is scarce – i.e., when snowshoe hare numbers are very low – lynx will venture onto the tundra for food (Environment Canada 2006) and supplement their diet with rodents and birds. Moose and caribou (usually calves) may account for some of the lynx diet, but they rarely attack large prey (Environment Canada website). From trapping data, it is probable that the population of lynx in and around the Project site is ‘very low’ (M. McGrath, pers. comm.). Lynx sign was noted during earlier surveys at Long Harbour (Albright & Wilson Americas 1992).

Aquatic and Semi-aquatic Furbearers

Four species of aquatic and semi-aquatic mammals are known or expected to occur in or around the Project site: river otter (*Lutra canadensis*), American mink (*Mustela vison*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicu*).

The river otter, part of the weasel family *Mustelidae*, is found throughout North America, inhabiting rivers, lakes, and coasts. Otters feed on fish, insects, molluscs, crustaceans, small mammals, and waterfowl, and occupy relatively large home ranges of 24 to 80 km^2. In coastal areas such as Placentia Bay, otters also forage in the ocean for fish, lobster, and likely other shellfish (M. Pitcher, pers. comm.). Brook trout is likely the primary fish species of choice in Newfoundland freshwater ecosystems, as well as eel, ouananiche, dragonfly larvae, and Atlantic salmon (M. Pitcher, pers. comm.). Directed surveys for otter were conducted during the marine program and results described in that section of this volume.

The American mink also occurs throughout Newfoundland. It is a carnivore like the otter and shares a similar diet, but may take a greater proportion of small mammals and birds. Fresh mink tracks were noted in the Project area in the winter of 2006 (JWL 2007b). Otters are dominant to mink and will usually kill them if their territory overlaps.

Beavers occupy rivers, streams, marshes, lakes, and ponds and exist in and around the Rattling Brook Big Pond watershed. Beavers may actually increase habitat diversity by damming small streams, which leads to increased species richness of plants and animals (Snodgrass 1997), While densities in Newfoundland tend to be the lowest in North America (Novak 1987), surveys at the project site during 2006, indicate that at least one active colony is present. Research elsewhere in Newfoundland indicates this group could represent over six individuals, on average (Payne 1982). This rodent feeds mainly on bark and twigs but will also eat leaves, grasses, herbs, berries, and aquatic plants. Their activity in freshwater environments can have considerable localized effects on the physical and biological components of riparian ecosystems (Sigourney et al. 2006). Like other furbearers (aside from the marten), beaver is trapped in Newfoundland (Payne 1984).

The muskrat also in the rodent family, inhabits marshes, pond and lake edges, and streams throughout Newfoundland, feedsing primarily on the roots and stems of aquatic vegetation and sometimes on clams, frogs, and fish. In 2006, a muskrat lodge was found in a wetland near the location of an otter family, but no muskrats were observed (JWL 2007a); it is possible that otters have taken over the lodge.

Big Game

Moose were introduced to Newfoundland in 1878 and 1904, with the second introduction considered successful. The species has rapidly expanded to all parts of the Island. Moose prefer coniferous forest, especially near wetlands and lakes with regenerating coniferous trees. The summer diet consists mainly of aquatic vegetation, deciduous trees, shrubs, and grasses. Considerable evidence of moose was found at the Project site during summer surveys in 2006 (JWL 2007b). It is probable that they use this area frequently, given the number of water bodies present. In summer, moose often cool off in water for several hours each day, foraging and avoiding the irritation of flies (Renecker and Schwartz 2005). Fresh tracks, droppings, bedding areas, and browsed vegetation indicated that moose are common in fall. Browsed species consisted primarily of balsam fir, willow, serviceberry, and white birch.

During winter, moose browse primarily on balsam fir, white birch, pin cherry, and willow; however, they prefer pin cherry followed by birch and willow (Parker and Morton 1978). In periods of excessive snow, their movements become impeded when depths exceed knee deep, and are essentially restricted when at chest height (Renecker and Schwartz 2005). Two wintering areas were identified during the late-winter surveys in 2006, at the outlet of Sandy Pond and on the south and east slopes of a large hill in the vicinity of the Project site (JWL 2007a). Both locations showed repeated use.

Woodland caribou (*Rangifer tarandus caribou*) are native to Newfoundland and move about seasonally. In spring they prefer evergreen and deciduous shrubs and sedges; in summer, they eat mainly deciduous shrubs and *Cladonia* spp. lichens, and fungi; in autumn, *Cladonia* spp. lichens; and in winter, arboreal lichens and evergreen shrubs (Bergerud 1972). The most southerly Canadian herd of Woodland caribou (numbering a few hundred animals) exists on the Avalon Peninsula, using the area from the Avalon Wilderness Area south to the Southern Shore. This is the closest caribou range to Long Harbour, approximately 60 km to the east. Caribou are not reported from the Long Harbour area and, since the habitat types they prefer are deficient, the area can be deemed insignificant for this species.

The black bear (*Ursus americanus hamiltoni*) Newfoundland population is recognized as a distinct subspecies. Black bear tend to exist in low densities by nature, and have large territories, making them difficult to monitor. The Newfoundland population was estimated at 6000-10,000 animals and was considered stable in the mid-nineties (Pelton et al. 1994). They have rarely been reported on the Avalon Peninsula and currently does not have an established population there. Lack of sightings indicate it is unlikely that there are black bears using the area around Long Harbour due to the poor bear habitat.

Terrestrial Species at Risk

Avifauna Species at Risk

Eleven populations of birds occurring in Newfoundland and Labrador have been listed as ‘species at risk’ by provincial and federal legislation (Table 2.7). The temporal and spatial occurrence of nine of the mostly ‘terrestrial’ populations in Placentia Bay are described below. The three marine species are described under ‘Marine Environment.’

Table 2.7 Species at Risk in Newfoundland and Labrador as listed by COSEWIC, *SARA* and ESA

	ESA	COSEWIC	*SARA*
Barrow's Goldeneye (eastern population)	Vulnerable[1]	Special Concern	Special Concern
Harlequin Duck (eastern population)	Vulnerable	Special Concern	Special Concern
Peregrine Falcon (*anatum*)	Threatened	Threatened	-
Peregrine Falcon (*tundrius*)	Threatened	Special Concern	-
Piping Plover	Endangered	Endangered	-
Ivory Gull	Vulnerable	Endangered	-
Red Knot	Endangered	Endangered	-
Short-eared Owl	Vulnerable	Special Concern	Special Concern
Gray-cheeked Thrush	Vulnerable	-	-
Rusty Blackbird	Vulnerable	Special Concern	-
Red Crossbill	Endangered	Endangered	Endangered

Note: [1]Vulnerable is a Newfoundland and Labrador designation equivalent to Special Concern for COSEWIC and *SARA*.

Barrow's Goldeneye Eastern Population

Barrow's goldeneye (*Bucephala islandica*) is designated as *vulnerable* under the *ESA* and a species of s*pecial concern* by COSEWC and *SARA*. The total population is about 4,500 birds, and the core breeding area is believed to be small lakes at high elevation in watersheds draining into the north shore of the Gulf of St. Lawrence. Indications of breeding in northern Labrador remain unsubstantiated and require further investigation. Summer moulting sites have been identified on the northeastern side of Hudson Bay, Ungava, Frobisher Bay, and the coast of Labrador from Nain northward (Schmelzer 2006).

At least 90% of the eastern Barrow's goldeneye population winter in the St. Lawrence estuary; approximately 400 winter in coastal Atlantic Canada and Maine, and in Newfoundland, small numbers have been documented wintering at the mouth of the Humber River near Corner Brook, in Traytown, Port Blandford, Spaniard's Bay, and St. Mary's Bay. There have been sightings at St. Paul's Inlet and Inner Newman Sound, and at least one sighting of Barrow's Goldeneye in Placentia Bay, an adult male and female at Arnold's Cove estuary 30 November 1993 (B. Mactavish, LGL, pers. comm.).

Barrow's goldeneye is very rare in Placentia Bay. Judging from the regular occurrence of a few wintering individuals in eastern Newfoundland, including the Avalon Peninsula (Spaniard's Bay and St. Mary's Bay), it is possible a few are wintering undetected among common goldeneyes in parts of Placentia Bay. The 1993 sighting from Arnold's Cove shows the species can occur in Placentia Bay during the non-breeding season.

Harlequin Duck Eastern Population

The eastern population of harlequin duck was designated as *endangered* by COSEWIC in 1990. During the 1990s an increased effort in research and monitoring of the species on breeding grounds, moulting sites, and wintering sites resulted in improved knowledge of their distribution. An increase in numbers at four key wintering sites in North America and the discovery that some eastern North American harlequins winter in southwest Greenland was instrumental in COSEWIC relisting it to a species of s*pecial concern* in 2001 (Environment Canada 2006). The eastern harlequin duck is legally listed (i.e., Schedule 1) as a species of s*pecial concern* under *SARA*.

The eastern harlequin breeds on rivers in northern Quebec (rivers draining in to the eastern side of Hudson Bay and Ungava Bay), Labrador (Nachvak Fiord to Hopedale), the western coast of Great Northern Peninsula, Gaspé Peninsula, and northern New Brunswick (Robertson and Goudie 1999). It winters on the coast, mainly from Newfoundland to Massachusetts, with more than half the population wintering in coastal Maine (Robertson and Goudie 1999).

In Newfoundland, harlequin duck is a coastal migrant and winterer, of which Cape St. Mary's has the largest known wintering population. Survey results in late winter 2005 and 2006 showed 200+ individuals between Point Lance and Cape St. Mary's (P. Thomas, CWS, pers. comm.). Cape St. Mary's Christmas bird count totals for the period 1997-2006 range from 51 to 200 individuals with an average of 120 (http://www.audubon.org/bird/cbc/hr/). Small numbers probably occur in northern reaches of Placentia Bay during migration and winter (October to April). Suitable habitat exists around small islands and rocky islets in zones of high energy. Potential habitat exists in the Iona Islands group at the mouth of the greater Long Harbour area. There are no known sightings for Long Harbour.

Peregrine Falcon

The peregrine falcon is practically cosmopolitan, breeding on all continents but Antarctica. It breeds throughout North America in low densities. In Canada, the two main subspecies are *anatum,* breeding in southern Canada, and *tundrius* in the Arctic and sub Arctic. The *anatum* is designated as *threatened* by COSEWIC. The *tundrius* is considered *threatened* by the Newfoundland and Labrador Special Status Advisory Committee (SSCA) and a species of s*pecial concern* by COSEWIC.

Anatum is generally darker with a stronger malar stripe than *tundrius*. Features overlap where the two subspecies meet in northern Canada. In Newfoundland and Labrador, the division in the breeding ranges of the two subspecies is approximately at the tree line in northern Labrador. The Peregrine Falcon does not nest on the island of Newfoundland, but is a mainly a fall migrant and a scarcer spring migrant. A few over-winter on the southern Avalon Peninsula.

In Placentia Bay, peregrine falcon occur mainly as an uncommon fall migrant with a few possible during spring migration. One or two over-winter in the Cape St. Mary's area every year. Both subspecies have been identified in Placentia Bay, but the ratio of the occurrence of *anatum* to *tundrius* is not known. They could occasionally occur in Long Harbour during fall migration.

Short-eared Owl

The short-eared owl was designated as a *vulnerable* species in Newfoundland and Labrador under the *ESA* in 2001. It is listed as a species of *special concern* in Canada by COSEWIC in 1994, and is of *special concern* under *SARA* Schedule 3. It breeds in North America, South America and Eurasia. It is widespread in Canada, breeding from the sub-Arctic southward. Distribution is patchy and numbers have declined in the United States and most of Canada. In Newfoundland and Labrador, it has been reported in tundra, coastal barrens, sand dunes, field, and bog habitats (Schmelzer 2005). short-eared owls feed on small rodents, mainly meadow voles in Newfoundland, and occasionally small birds that are surprised in the low vegetation (grasses) of coastal locations. In the early 1990s, a pair summered at the Argentia airbase and was suspected of breeding (B. Mactavish, LGL, pers. comm.). They are also regular during the breeding season (April-September) in the Cape St. Mary's area. In Placentia Bay, the species is expected to occur locally in small numbers from April to November. Suitable open terrain exists at Cape St. Mary's, the former Argentia airbase, and various sites on all coasts of Placentia Bay. Migrating short-eared owls might turn up at any coastal site, including Long Harbour, from April-May and September to November.

Gray-cheeked Thrush

The gray-cheeked thrush is listed as *vulnerable* in Newfoundland and Labrador by SSAC. The analysis of data from 21 Breeding Bird Surveys routes on insular Newfoundland indicates a major decline between 1980 and 2003 (Dalley et al. 2005).

The breeding range of the gray-cheeked thrush is northern boreal forests near the tree line from Alaska to Newfoundland and Labrador (Godfrey 1986). It winters from southern Mexico south to Brazil (Godfrey 1986), and occurs in Newfoundland from late May to September. The preferred breeding habitat includes dense low coniferous woods, open canopy old growth forest having dense growth of small conifers in the understory, and dense stunted spruce and fir on windblown sites on the coast or at higher elevations. The species is an uncommon breeder on the west side of Placentia Bay, preferring the steep slopes of the coastal enclaves including the Placentia area (B. Mactavish, LGL, pers. com). They may breed in the dense low conifer forest of outer Long Harbour, although a recent insect infestation that killed many of the trees bordering Long Harbour has probably reduced the available breeding habitat.

Rusty Blackbird

The rusty blackbird is listed by COSEWIC as a species of s*pecial concern*. It breeds throughout the boreal forest of North America from Alaska to Newfoundland and Labrador, and winters from southern Canada to Mexico (Godfrey 1986). In Newfoundland and Labrador, it is a widespread breeder on lakes, waterways, and bogs from late April to October. Evidence of a continent-wide decline within the breeding range and wintering areas has resulted in COSEWIC placing the on the s*pecial concern* list. Reasons for the overall population decline are unknown.

Suitable habitat exists in freshwater wetlands around Placentia Bay, although it is probably a scarce bird during late April to October. It was observed incidentally outside the Project Area during the baseline surveys.

Red Crossbill

The red crossbill is widespread in coniferous forest of North American south in mountains to Nicaragua (Godfrey 1986). The Newfoundland subspecies *percna* is listed as e*ndangered* under *SARA* Schedule 1 and the *ESA*.

A sharp decline in red crossbills recorded on Christmas Bird Counts from 1968 to 2002 shows a 75% decrease per decade (COSEWIC 2004 *in* Environment Canada 2006). The reasons for decline are uncertain, but the decline of white pine (*Pinus strobus*) caused by the accidental introduction of white pine blister rust (*Cronartium ribicola*), widespread logging, and the introduction of the red squirrel (*Tamiascriurus hudsonicus*) may be contributing factors (Environment Canada 2006). The Avalon Peninsula is one of the remaining strongholds in Newfoundland. In 2005 and 2006, there were reports from several feeder watchers in the Trinity Bay and Bay Verde Peninsula area (B. Mactavish, LGL, pers. comm.). Nesting in the Whitbourne area was confirmed when adults that had been using a feeder on a daily basis brought juveniles to the feeder in June (B. Mactavish, LGL, pers. comm.). One bird was encountered flying over inner Long Harbour on 21 July 2006. The forest habitat around Long Harbour is homogenous with the surrounding parts of the Avalon Peninsula and is only 20 km from Whitbourne, where red crossbills were known to breed in 2005 and 2006. The species probably occurs annually in small numbers and potentially could nest in the Long Harbour area, where it was observed (but outside the Project Area) during baseline surveys in 2006.

Of the avian species at risk known to occur in insular Newfoundland and more specifically in the southern Avalon region, only the Red Crossbill and Rusty Blackbird have been recently reported in the vicinity of the Project site (B. Mactavish, LGL, pers. comm.).

Plants

A search of the Atlantic Canada Conservation Data Centre (AC CDC) database of known rare plant species within five kilometres of the Project site was conducted during the baseline field investigations (JWL 2007b). Rare plant species are defined as those designated with sub-national (provincial) rank of S1 and S2 as determined by the provincial Wildlife Division of the Department of Environment and Conservation. The ranking criteria are shown in Table 2.8.

Table 2.8 Definitions of the Atlantic Canada Conservation Data Centre "S" Rankings

S Rank	Description
S1	Extremely rare throughout its range in the province (typically five or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in some locations (21 to 100 occurrences).
S4	Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the species is of long-term concern (e.g., watch list) (100+ occurrences).
S5	Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (e.g., S1S2).
?	Inexact or uncertain: for numeric ranks, denotes inexactness (e.g., SE? denotes uncertainty of exotic status). (The ? Qualifies the character immediately preceding it in the S RANK).
SU	Unrankable: Possibly in peril, but status is uncertain - more information is needed.
SH	Historical: Previously occurred in the province but may have been overlooked during the past 20-70 years. Presence is suspected and will likely be rediscovered; depending on species/community.
SR	Reported but without persuasive documentation (e.g., misidentified specimen).

The search of the ACCDC indicated that no rare plants were known to occur within five kilometres of the Project site.

The surveys in 2006 focused on areas considered to have the highest potential to contain rare species (JWL 2007): riparian zones, wetlands, groundwater seepage sites and unique geological landforms such as limestone rock outcrops. Of the 70 species identified, only one water horehound or bugleweed (*Lycopus americanus*) (S2), was found, in only one location, a small riparian habitat within a balsam fir forest. No S1 ranked species were observed within the surveyed areas. Figure 2.3 presents the locations of all rare plant survey plots including the location of *Lycopus americanus* (JWL 200b).

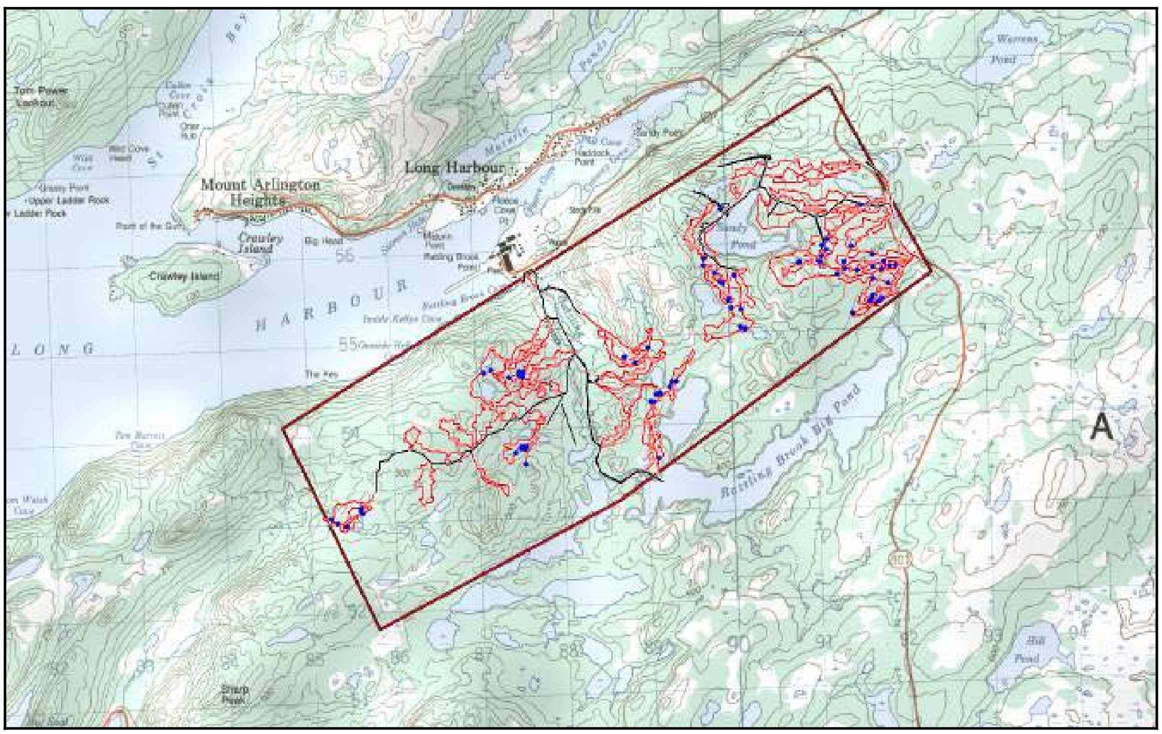
An organism of particular interest in the surveys is the boreal felt lichen (*Erioderma pedicellatum),* listed as critically *endangered* on a global basis by the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (IUCN 2006). The Newfoundland (Boreal population) is listed as *special concern* under the federal *SARA* (Schedule 1) and by COSEWIC. It is listed as v*ulnerable* under the *ESA*.

Figure 2.3 Rare Plant Plot Locations

The boreal felt lichen is a conspicuous lichen, discovered in the early 19th century and may occur in two regions of the world, namely Scandinavia (Sweden and Norway) and Atlantic Canada (Island of Newfoundland, Nova Scotia and New Brunswick). All known populations from New Brunswick have disappeared and the Nova Scotia population has collapsed during the past 20 years (Maass and Yetman 2002). The North American distribution of this species is now mainly restricted to several sites in Newfoundland; however its populations at many locations have either disappeared since the first reports in the 1970s (Ahti and Jørgensen 1971), or are in decline, e.g., Lockyer's Waters (I. Goudie, pers. comm.).

In early 2006, VBNC approached the Newfoundland Lichen Education and Research Group (NLERG) to undertake a reconnaissance of the Long Harbour area in order to assess the presence of this lichen. Surveys and reporting were conducted by C. Scheidegger, Lichen Specialist Group of the IUCN, I. Goudie, and E. Conway, who spent approximately 300 hours searching over a 20 km^2 area from 1 June to 6 September 2006.

Approximately 30,000 trees were surveyed. Of these, 60 were documented as hosting 97 thalli *of E. pedicellatu;,* that is, phorophytes represented approximately 0.22% of Balsam Fir stems (Figure 2.4). This represents the first documentation of the lichen in the Long Harbour area. It had previously been documented in the area of Ship Harbour (W. Maass, pers. comm.) and also in the inner portion of Placentia Bay, and a population in the area of southeast Placentia is monitored with support from VBNC.



(Irregular red lines represent field searches, and blue dots indicate locations of host trees)

Figure 2.4 Results of Surveys for *E. pedicellatum* in the Long Harbour Area in 2006

Erioderma identified in this study occurred in cool, moist habitat in areas of scrub and forest cover. Southwestern Barrens subregion locations have cool summers with frequent fog and strong winds and winters that are relatively mild with intermittent snow cover particularly near the coastline. Annual precipitation exceeds 1250 mm (Protected Areas Association 2000).

2.3 Freshwater Environment

Extensive surveys of the Long Harbour Project Area were conducted in 2005-06 as part of the baseline characterization. These surveys included sampling for fish species presence, habitat mapping, hydrological data collection, water and sediment quality, macroinvertebrate and related biophysical (groundwater and wetland) surveys. From a review of historic information and baseline studies an overview of the existing freshwater environment within the Project site has been developed. Readers are referred to the individual baseline Component Studies for supporting details.

2.3.1 Surface Water

Historic sampling conducted in ponds in the Long Harbour area indicates that pond water is typically high colour, low conductivity and very soft (O'Connell and Andrews 1987). Past sampling of ponds located to the north-east of the former plant (the direction of prevailing winds) indicated elevated levels of phosphate, calcium, and fluoride, which were assumed to be the result of airborne phosphate ore-dust from the phosphorus plant property (*see* O'Connell and Andrews 1987; Lake 1984). The effect on pond ecology at the time was an enrichment process (eutrophication) and an increase in the level of water hardness during the open water season.

Public concern regarding fluoride levels in the environment during the 1970s prompted DFO to examine fish flesh from samples collected in ponds downwind of the plant between Long Harbour and the Trans Canada Highway (Albright and Wilson 1992). The study was conducted circa 1982-83 (2-3 years after the installation of stack scrubbers at the phosphorus plant) and indicated no elevated levels of fluoride in any samples analyzed.

The 2005-06 surface water sampling program included ponds within the direct footprint of the Project site as well as many that might serve as reference or control locations. The total suite of parameters analyzed and the results are presented in the Freshwater Component Study (AMEC 2007a).

The water quality of the Rattling Brook watershed is similar to that of other watersheds in the area, acidic with a pH of less than 7.0. With a lower pH come elevated levels of some metals above Canadian Council of Ministers of Environment (CCME) Guidelines for the Protection of Freshwater Aquatic Life (CCME 2006). Metals such as aluminum and cadmium show consistently elevated levels while copper, iron, lead, arsenic, and nickel show occasional elevated levels, particularly in summer and fall. Occasional elevations in these metals were reported from the smaller plateau ponds (P22, P23 and S30 [Figure 2.6]). Arsenic was above CCME Guidelines in the Rattling Brook watershed in Pond P28 (surface and mid-depth) from the August 2006 sampling. These levels are generally indicative of the surficial geology of the area and reflect groundwater influences.

Fluoride was also sampled in all ponds as part of the 2006 program. While there are no applicable CCME guideline values, the Canadian Drinking Water Quality Guidelines identify an upper limit of 1.5

mg/L (CCME 2006). Results from ponds and brooks in the 2006 program showed all fluoride levels less than 0.2 mg/L (AMEC 2007a).

The water quality of the Sandy Brook watershed is similar to that of other watersheds in the area. This includes being acidic with a pH of less than 7.0. Similar to the Rattling Brook watershed, there have been elevated levels of some metals identified above CCME Guidelines for the Protection of Freshwater Aquatic Life (CCME 2006). In general, aluminum showed consistent elevated levels while cadmium, copper, iron, lead, and mercury were occasionaly elevated, particularly in spring and summer.

Fluoride was sampled as part of the 2006 sampling program in all ponds. As with the Rattling Brook watershed, results show fluoride levels less than 0.2 mg/L (AMEC 2007a) indicating baseline levels and no likely residual effects from past industrial activity.

Water samples were collected from a sub-tributary of Little Rattling Brook during the 2006 program. Like the nearby small plateau ponds, Little Rattling Brook also had a low pH and elevated aluminum, cadmium, and iron levels (AMEC 2007a). The brook also had elevated mercury levels above CCME guidelines.

2.3.2 Groundwater

Regional

On a regional scale groundwater occurs in two major hydrostratigraphic units: within a relatively thin overburden usually composed of glacial or glacio-fluvial deposits, and within lower Paleozoic fractured bedrock.

Overburden soils are generally rich in sands and coarser particles, and contain little fines (i.e., silt and clay size fractions). This results in a highly permeable shallow groundwater regime characterized by relatively rapid flows and a high connectivity with surface water bodies. As a consequence, recharge of groundwater by surface seepage occurs soon after rainfall events and is quickly followed by discharge of groundwater to the surface at springs, streams, ponds, and other water bodies.

Primary porosity of the sedimentary and volcanic bedrock in the Study Area is generally quite low; therefore, groundwater flow in this unit is primarily through fractures, joints, faults, shear zones, and other open discontinuties that transect various geologic formations. In general, there is a trend of decreasing permeability (and well yield) with depth that reflects a corresponding decrease in discontinuity frequency and aperture width.

Because of the relatively high permeability of overburden material and upper levels of fractured bedrock, shallow groundwater quality is often very similar to that of surface water (freshwater) bodies. Typically, these waters are very low in total dissolved solids, less than 25 mg/L, pH levels are generally between 4 and 6.5, and average alkalinity and hardness values are less than 10 mg/L.

The quality of bedrock groundwater can be quite different from that of shallow overburden groundwater and typically reflects the water's longer residence time within various geologic formations. There are three types of bedrock groundwater: Group I - calcium bicarbonate, with appreciable hardness and alkalinity (>50 mg/L as $CaCO_3$), and pH values between 6.5 and 9; Group II – sodium bicarbonate, with high alkalinity, low hardness, and high pH (>8); and Group III, which is very soft, acidic (pH 4.0 – 5.5), low in alkalinity, and low in total dissolved solids (Gale et al. 1984).

Local

Based on the hydrogeological characterization study carried out by AMEC (2007b), three hydrostratigraphic units were identified in the Project Area.

- Till (HU1): This unit overlies bedrock and consists of sand and gravel with less than about 20% fines. Glacial till is prevalent in areas of thicker overburden (> 12 m thick) and high water table. The hydraulic conductivity of this unit is believed to about 10^{-3} to 10^{-4} cm/s, and the effective porosity is likely between 0.3 and 0.4.

- Till / Bedrock Contact Zone (HU2): This unit is prevalent in areas where glacial till is less than 12 m thick, which includes most of the Project Area. Measured hydraulic conductivities (K) range from 10^{-3} to 10^{-4} cms. It is believed that the horizontal K (K_h) is greater than the vertical K (K_v) based on the observed fracture network in the till / bedrock contact zone. The effective porosity within this unit is unknown, but is surmised to range between 0.01 and 0.1

- Bedrock (HU3): This unit underlies all of the Project Area and is important at depths greater than 12 m or where overburden deposits are absent. The measured hydraulic conductivities vary widely over the range of 10^{-3} to 10^{-6} cm/s (AMEC 2007c)

On average, groundwater is found at about 3.2 m below ground surface throughout the Project Area, and is encountered at depths ranging from surface to about 9 m. The water table generally mimics the ground surface, except where it discharges into streams, ponds, springs, or the marine environment of Long Harbour. Zones of higher groundwater flux are likely to be focussed in areas of localized topographic and bedrock lows, especially in areas with thicker saturated overburden and fractured bedrock contact zones.

Groundwater flow in the Study Area is heavily controlled by the occurrence of ponds and streams, marine waters of Long Harbour, and bedrock highs. Shallow groundwater flows can be approximated by surface flows within drainage basins. As an example, shallow groundwater within the proposed plant site is believed to flow towards Long Harbour along a broad pathway that centres on Rattling Brook (AMEC 2007b). Similarly, shallow groundwater has been modelled and found to flow from the area of Sandy Pond and along a broad pathway that centres on Sandy Brook.

The pathways followed by deep groundwater are less influenced by local topographic irregularities than those of shallow groundwater (AMEC 2007b), however, deep groundwater flow around Sandy Pond has been shown through modelling to flow in the same general direction as the shallow groundwater (AMEC 2007c).

Based on AMEC studies (2007b and 2007c), the area of potential influence on groundwater resources associated with the Project is essentially confined to the Project site shown on Figure 2.5. Zones of groundwater recharge are typically found in areas of topographic highs and along steep slopes. Groundwater discharge to the surface often typically occurs into ponds, streams, and at the foot of steep slopes where topographic gradients decrease or flatten out.

The chemistry of the groundwater across Tier 2 of the Project area is quite similar and can be classified as Group I – calcium bicarbonate type groundwater. Within HU1 and HU2 groundwater is slightly more acidic and has a lower TDS content than that collected from HU3 in deeper bedrock. With depth, there is a trend towards increasing calcium, bicarbonate, alkalinity, harness, and pH level. An analysis of the groundwater major ion chemistry suggests that groundwater is mixing from two different sources: young infiltrating rain water (HU1 and HU2) and older bedrock groundwater (HU3) (AMEC 2007b).

In HU1 and HU2, iron levels above the freshwater and / or marine aquatic life criteria of the *Canadian Environmental Quality Guidelines (CEQG)* are typical, whereas iron concentrations are usually lower or non-detectable in HU3. Manganese levels are characteristically elevated in all three hydrostratigraphic units (AMEC 2007b).

Other metals that were found at elevated levels with respect to these criteria include arsenic, cadmium, copper, lead, zinc, and aluminum. These levels may be related to leaching from the till and sediments within the Project site, but may also be the result of deposition of airborne contaminants during operation of the phosphorus plant in the Lower Tier I area (AMEC 2007b).

Within the Lower Tier I area the primary contaminants of concern are free cyanide, elemental phosphorus (P_4), and fluoride, which are associated with past operations at the site. Other chemicals found at elevated levels include sulphate, total phosphate, arsenic, iron, and manganese, all of which may be naturally occurring or derived from anthropogenic sources. Previous work carried out to support the decommissioning of the phosphorus plant concluded that P_4 is practically immobile and would never reach the marine environment of Long Harbour. Groundwater modelling of free cyanide and fluoride indicated that the plumes had reached steady state and that the concentrations would remain constant over time (AMEC 2007b).

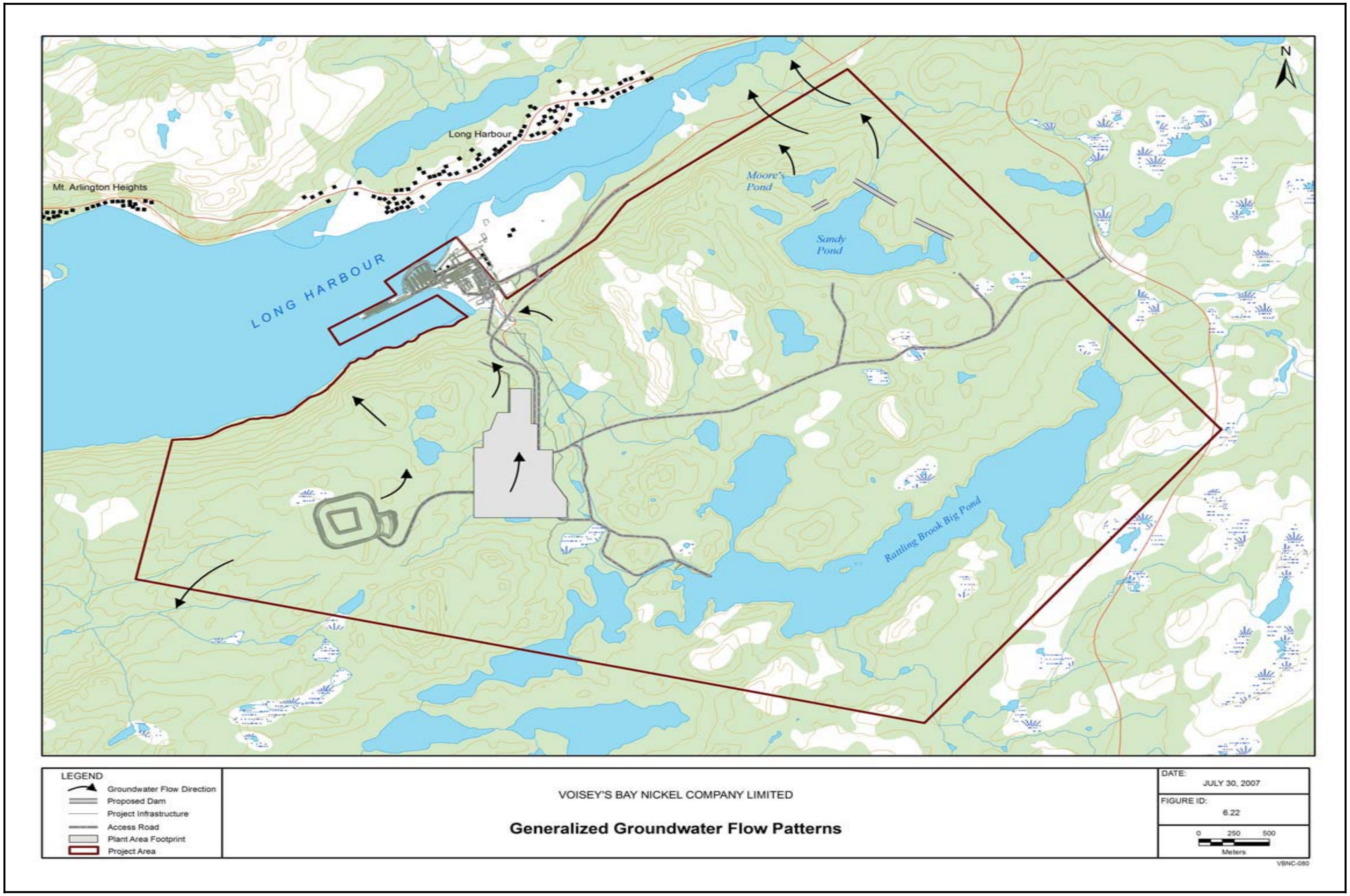


Figure 2.5 Generalized Groundwater Flow Patterns

Sandy Pond is the site of the proposed subaqueous residue disposal facility associated with the Project. AMEC (2007b and c) did extensive testing on groundwater collected from the area around Sandy Pond for a wide variety of inorganic parameters. Those of primary concern, based on surface water quality modelling, are nickel, copper, iron, and sulphate. The background concentrations reported for groundwater within this area are 0.0017 mg/L (Ni), 0.004 mg/L (Cu), 0.5 and 0.05 mg/L (Fe, for overburden and bedrock, respectively), and 2.7 mg/L (Sulphate).

2.3.3 Fish Habitat

It is important to understand the Project Area's hydrology, in particular that of the Rattling Brook and Sandy Brook watersheds, as VBNC will require water extraction for the refining process; engineering design for water and effluent containment; and, water monitoring as part of its operations (e.g., waste water from the marine diffuser, diversion water around the Project footprint, Sandy Pond containment efficiency).

To address this, VBNC has installed hydrographs in the Project area and conducted an extensive groundwater characterization study (AMEC 2007b). Appropriate aspects of these reports are provided below.

The streams are relatively small in size and many of them have been delineated as intermittent on provincial 1:50,000 topographic mapping. Aquatic mapping was completed for streams (AMEC 2007a) and classified in accordance to both the Beak (1980) and a more recent habitat classification system (McCarthy et al. 2007).

The mapping of the habitat types present was conducted using standard stream survey methods (see Scruton et al. 1992; Sooley et al. 1998; McCarthy et al. 2007), Global Positioning System (GPS) and Geographic Information Systems (GIS). GIS was used to present the location of each habitat type as well as to calculate overall aerial extents. Each pond was surveyed for fish habitat as per the DFO requirements for lacustrine habitat classification/quantification (Bradbury et al. 2001a).

Of the five watersheds within the Long Harbour area, two are directly within the footprint of the Project. If the Matte Plant were built, a third watershed would be affected. Provided below is a general description of the existing environment within each of these three watersheds: Rattling Brook, Sandy Brook and Little Rattling Brook. The material presented below has been summarized from the Freshwater Component Study (AMEC 2007a) and utilizing the labeling system for watersheds, streams tributaries and ponds as described in that report and shown in Figure 2.6.

Rattling Brook (S20)

The Rattling Brook watershed extends inland approximately 6.5 km from the southern shore of Long Harbour. It drains a total area of 38 km^2, with the majority of this coming from Rattling Brook Big Pond (23.5 km^2), and its outflow is near the existing Long Harbour Industrial Park and wharf. This watershed contains many large and small ponds with a large network of tributaries, most identified as intermittent in nature. Figure 2.6 presents the Long Harbour area and the watershed boundaries. Fish species in the watershed are brook trout with limited use by American eel and resident Arctic charr.

The Plant site will be located within the Rattling Brook watershed, principally within small tributaries draining from the west (T1-1 and T1-1-1– AMEC 2007a). The water required for processing will also be extracted from Rattling Brook Big Pond. This proposed location is similar to that used by the former AWA plant in Long Harbour.

Main Stem (T1)

The main stem of Rattling Brook is 3.17 km between its mouth at Long Harbour and its origin at Rattling Brook Big Pond. It is relatively small with a series of very steep rapids at its mouth, making it inaccessible to anadromous salmonids (Figure 2.7), although American eel were captured just above the existing concrete weir approximately 400 m from mouth. In addition to the falls and cascades below the weir, a second set of steep falls and rapids approximately 200 m upstream of the weir are totally impassible (Figure 2.8).

The substrate composition is primarily cobble and larger, up to and including bedrock. Indications of past channelization in the area are evident. Gravels and smaller substrates occur in relatively low quantities, typically located in isolated patches behind larger boulders. There are, however, small areas identified that contain suitable gravels and are recorded as supporting brook trout spawning activity in September 2006.

The Beak habitat classification quantifies the main stem as a total of 20.50 units of Type I (spawning), 313.73 units of Type II (rearing), 39.07 units of Type III and 225.58 units of Type IV (pool) habitat. The proposed DFO Classification System identifies a total of 265.60 units of Riffle, 176.15 units of Pool / small pond, 17.25 units of Rapid, 86.62 units of Steady, 14.95 units of Cascade, 26.24 units of Falls and 12.06 units of Run habitat types.

This stream has also been subject to channelization and damming as part of past industrial use.

- A wooden-creosote water pipeline between Rattling Brook Big Pond and the Long Harbour Industrial Park
- A concrete weir in the brook approximately 400 m upstream from the mouth
- A rock-fill dyke on the outflow of Sam Howe's Pond (P14)

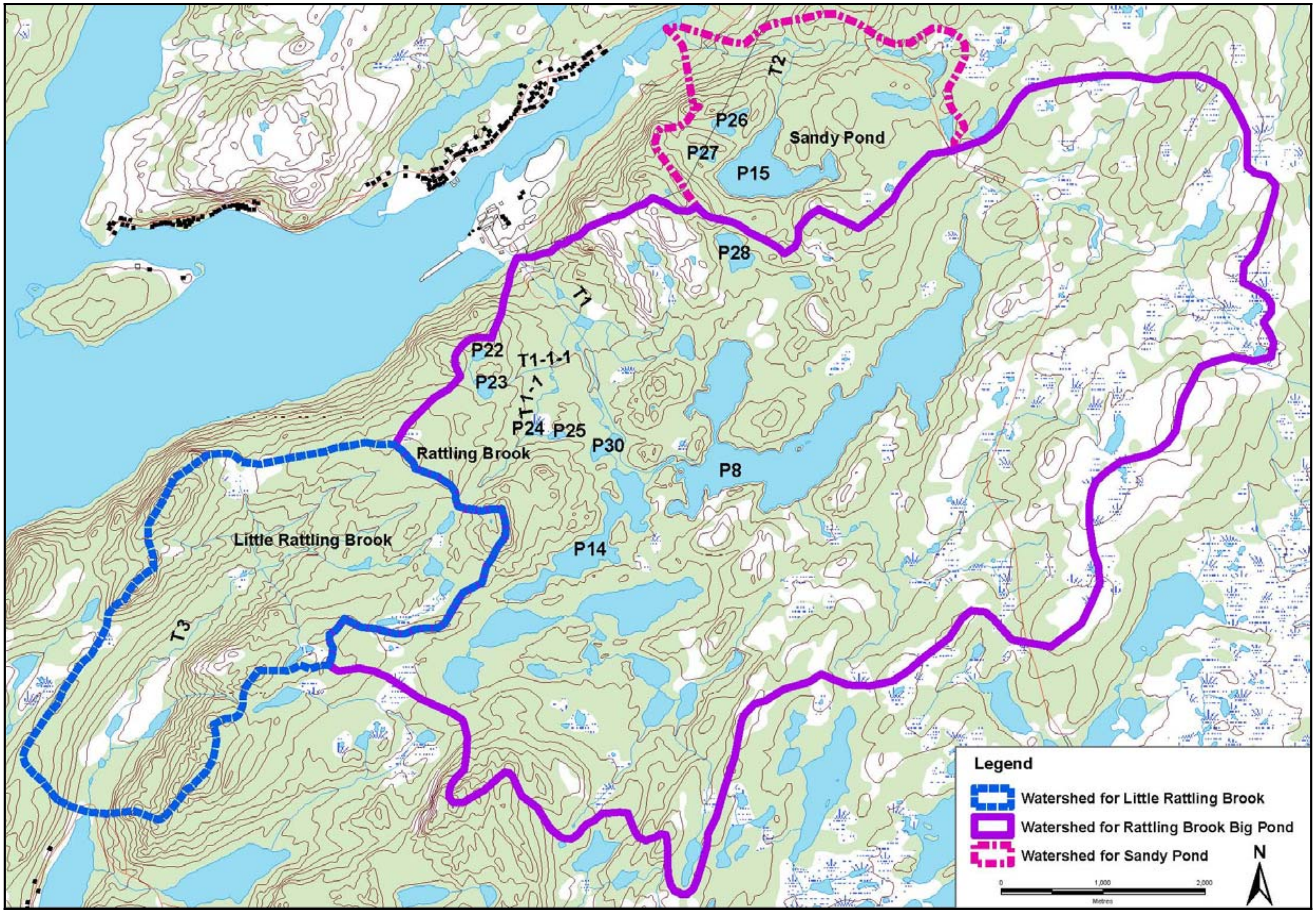


Figure 2.6 Watersheds within and Adjacent to the Project Area

Figure 2.7 The Falls at the Mouth of Rattling Brook, June 22, 2006

Figure 2.8 Barrier to Upstream Fish Migration, 200 m Upstream of Concrete Weir, June 22, 2006

The pipeline is still in place, but does not present a major alteration of aquatic habitat and does not pose a barrier to migration. The concrete weir is approximately 4.5 m high with a vertical downstream face (Figure 2.9). The weir would be a complete obstruction to fish passage; however, the right-hand side has eroded, leaving a small side channel that, at certain flows, may provide passage. The rock-fill dyke, constructed to keep water levels high for water extraction by the phosphorus plant (Figure 2.10), is approximately two metres high with a downstream slope estimated at 60°. The dyke is still in place but leaks, and during low to moderate flows, water exits the pond through the dyke itself with no clear channel for fish movement (i.e., the top of the dyke is dry). During high flows, the water crests the dyke and flows over its downstream face. This dyke is an obstruction to fish passage.

Stream channelizations have also occurred in at least two locations in the main stem. The first is just downstream of the upper bridge crossing when, large boulders have been removed and placed along the left-hand shore (Figure 2.11). The habitat is more uniform than most other locations. Gravels from the road and bridge have accumulated behind the downstream left-hand bridge abutment and at the downstream end of Reach 20, providing spawning habitat.

Figure 2.9 Concrete Weir Near the Mouth of Rattling Brook, June 22, 2006

Figure 2.10 Rock-fill Dyke at the Outflow of Sam Howe's Pond (P14) during High Flow, January 8, 2007

Figure 2.11 Rattling Brook Reach 21 Showing Channelized Habitat, June 22, 2006. Large Boulders were Removed and Placed Beyond the left-hand bank

The second channelized section located at the outflow of a small pool/pond, is approximately 360 m long and is more uniform than most other locations (Figure 2.12). Substrates are primarily cobble and rubble over steep gradient. At the time of the survey, water velocities as high as 0.75 m/s were recorded.

Figure 2.12 Rattling Brook Reach 34 Showing Channelized Habitat, June 22, 2006. Large boulders were removed and placed beyond the left-hand bank.

Hydrology

The hydrology of the system has been established from past records as well as from a new water-level station installed in the main stem of Rattling Brook in the fall of 2006. Figure 2.13 presents the hydrographs for a typical, dry and wet year; Figure 2.14 presents the flow duration curve.

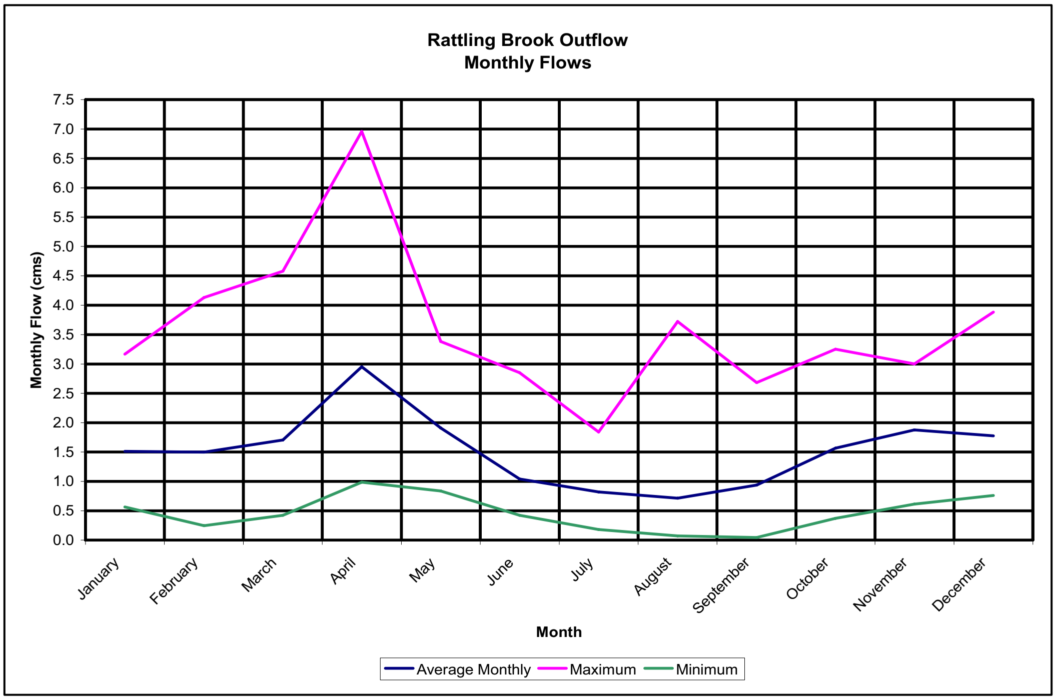


Figure 2.13 Hydrographs (typical, wet and dry year), Rattling Brook Outflow

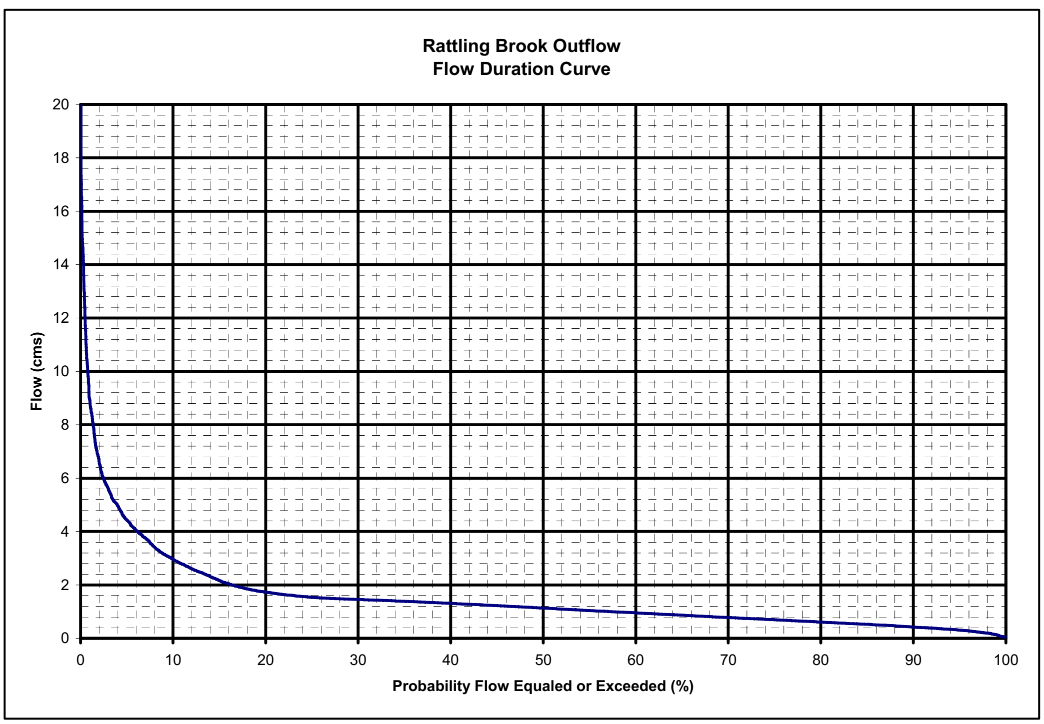


Figure 2.14 Flow Duration Curve, Rattling Brook Outflow

Beaver Brook Tributary

The Plant site will be located within the watershed of this sub-tributary. Beaver Brook is a tributary to Rattling Brook, which joins the main stem at Reach 17 (see Figure 2.6). It has a total drainage basin of 2.1 km^2 and extends inland to the west from the main stem approximately 1.8 km. Its headwaters empty two small ponds (P24 and P25). An additional sub-tributary drains a second set of small ponds (P22 and P23) into Beaver Brook from the west.

Beaver Brook has approximately 2.33 km of fluvial habitat. The tributary is shown as intermittent on 1:50,000 topographic mapping. It has very heavy riparian vegetation with excessive large woody debris throughout the upper reaches. The slope of the tributary tends to increase upstream toward the ponds. At the time of the surveys, there were no barriers to migration. The substrate composition is primarily rubble and boulders with some bedrock; gravels are noticeably absent in the tributary (except for a single reach at the downstream end). The tributary begins with a culvert that crosses the access road to Rattling Brook Big Pond. It has a diameter of approximately 1.1 m with no evidence of excess erosion due to extreme flows.

The fish species in Beaver Brook is brook trout. The Beak habitat classification quantifies the tributary as a total of 0.28 units of Type I (spawning), 28.51 units of Type II (rearing), 8.22 units of Type III (migratory) and 55.9 units of Type IV (pool) habitat (excluding Ponds). The proposed DFO Classification System identifies a total of 28.47 units of Riffle, 38.45 units of Pool, 17.76 units of Steady and 8.11 units of Cascade habitat types.

The hydrology of the system has been pro-rated from past records as well as from the new water-level station installed in the main stem of Rattling Brook in fall 2006. Figure 2.15 presents the hydrographs for a typical, dry and wet year for the tributary while Figure 2.16 presents the flow duration curve.

Rattling Brook Lacustrine Habitat

Six ponds within the Rattling Brook watershed could potentially be affected by the Project. Each pond was sampled for a variety of parameters contained in baseline data reports and component studies (JWEL 1997, 1998, 2003; AMEC 2005, 2007a). A summary of the habitat within each is provided below.

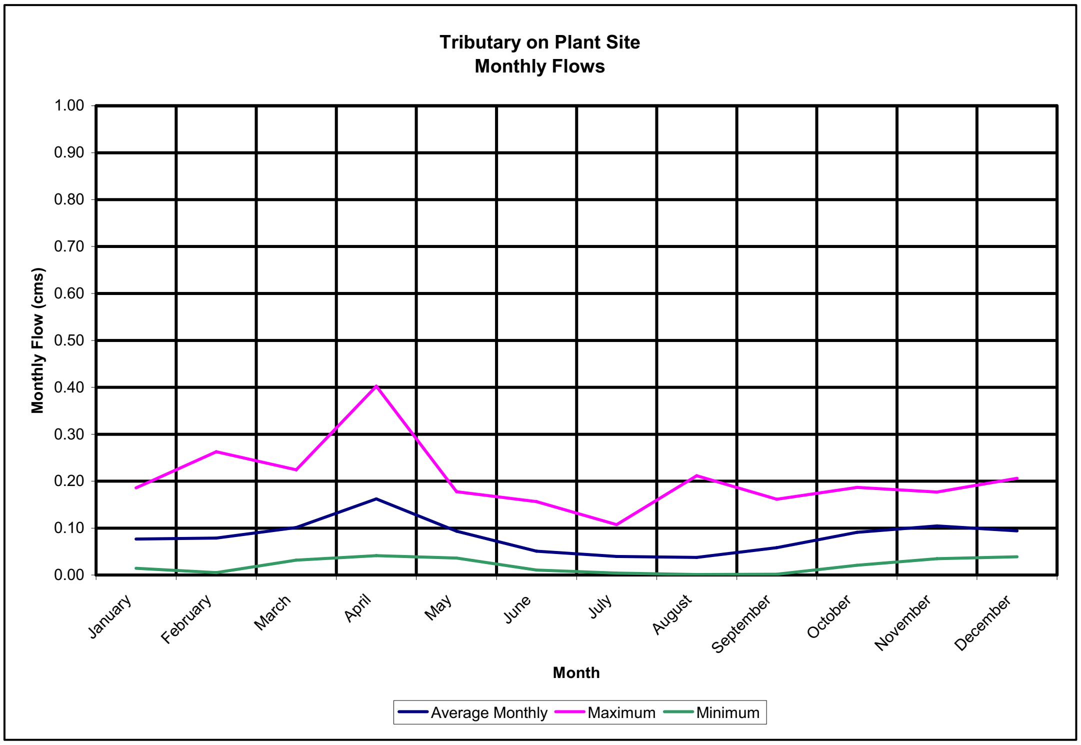


Figure 2.15 Hydrographs (Typical, Wet and Dry Year), Beaver Brook Outflow

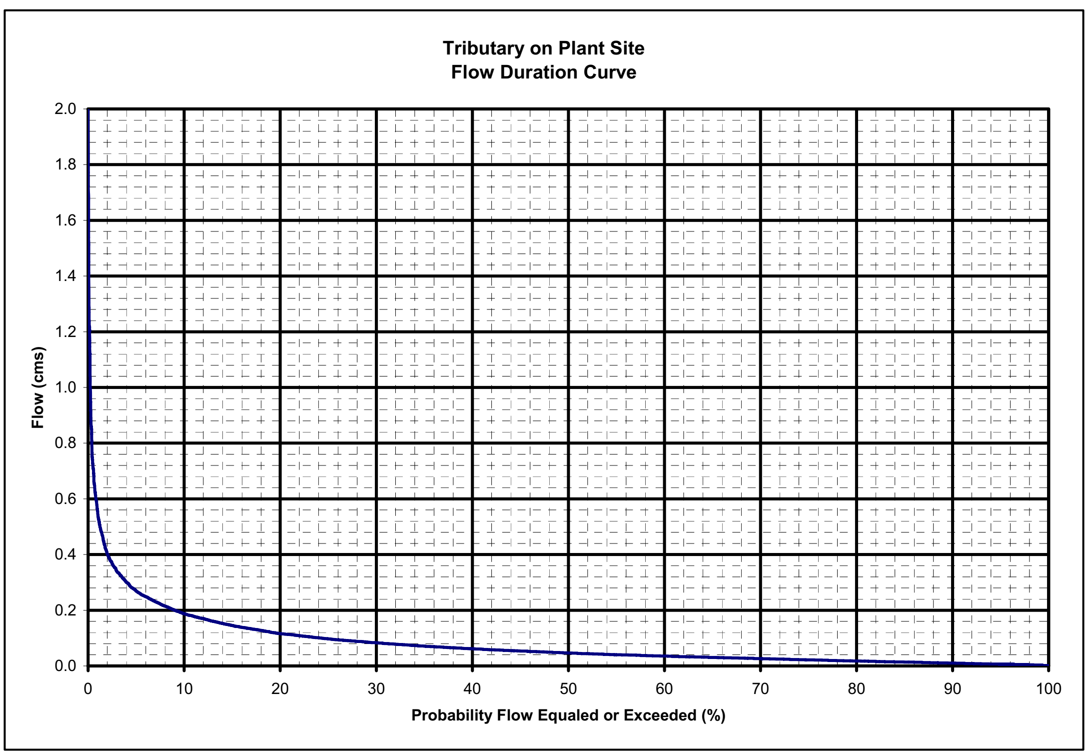


Figure 2.16 Flow Duration Curve, Beaver Brook Outflow

Rattling Brook Big Pond (P8)

Rattling Brook Big Pond is situated at the headwater of Rattling Brook and is the largest of all waterbodies within the Project area, with a total surface area of 189.29 ha. It lies at a general elevation of 105 m asl, in a bedrock-rimmed basin with ridges to the south rising 50-60 m above the existing pond. The pond axis lies in a general northeast-southwest direction.

The pond has a drainage area of 23 km^2. The average depth of light penetration within the water column was determined to be 3.6 m with a maximum pond depth measurement of 36 m. The shoreline comprises boulder, bedrock and rubble with deeper zones comprised of fines (organics and detritus). Emergent vegetation is present/visible, primarily in a shallow area in the north-east end and near the outflow at the western end. Figure 2.17 presents the bathymetric contours.

The littoral and profundal zones were delineated using ArcGIS™ software and digital bathymetric mapping. The total littoral and profundal habitat surface areas are 83.10 and 106.19 ha respectively. Table 2.9 summarizes the fish habitat types within Rattling Brook Big Pond.

The shoreline is relatively pristine and undeveloped; however, several cabins are located along the shoreline of the small northern alcove and at the north-east end. Water extraction infrastructure still remains near the outflow. The original maintenance and access road still provides access to the pond from the Long Harbour Industrial Park and is used extensively by local anglers and hunters. Several boats are stored where the road meets the pond.

Pond P14 – Sam Howe's Pond

Sam Howe's Pond is located on the main stem of Rattling Brook just downstream of Rattling Brook Big Pond. It has a total surface area of 38.08 ha and lies at a general elevation of 90 m asl in a relatively low-lying valley with surrounding low hills. The pond lies in a general north-east direction, similar to Rattling Brook Big Pond.

The drainage area is 32.9 km^2, which includes the outflow from Rattling Brook Big Pond. The average depth of light penetration within the water column was determined to be 2.6 m with a maximum pond depth of 12.3 m. The shoreline comprising boulder and rubble with deeper zones comprised of fines (organics and detritus) with no aquatic vegetation. Figure 2.18 presents the bathymetric contour of Pond P14 as modeled from the data. The total littoral and profundal habitat surface areas are 8.89 and 3.19 ha respectively. Table 2.9 summarizes the fish habitat types within Sam Howe's Pond.

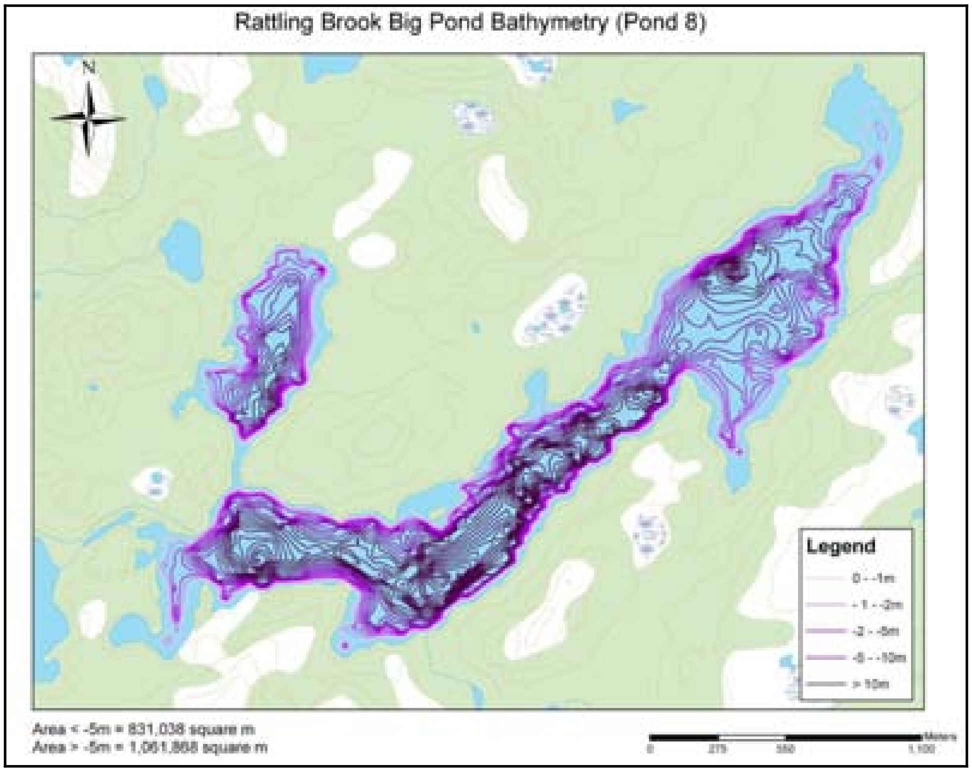


Figure 2.17 Rattling Brook Big Pond (P8) Bathymetric Contours, August 16, 2006

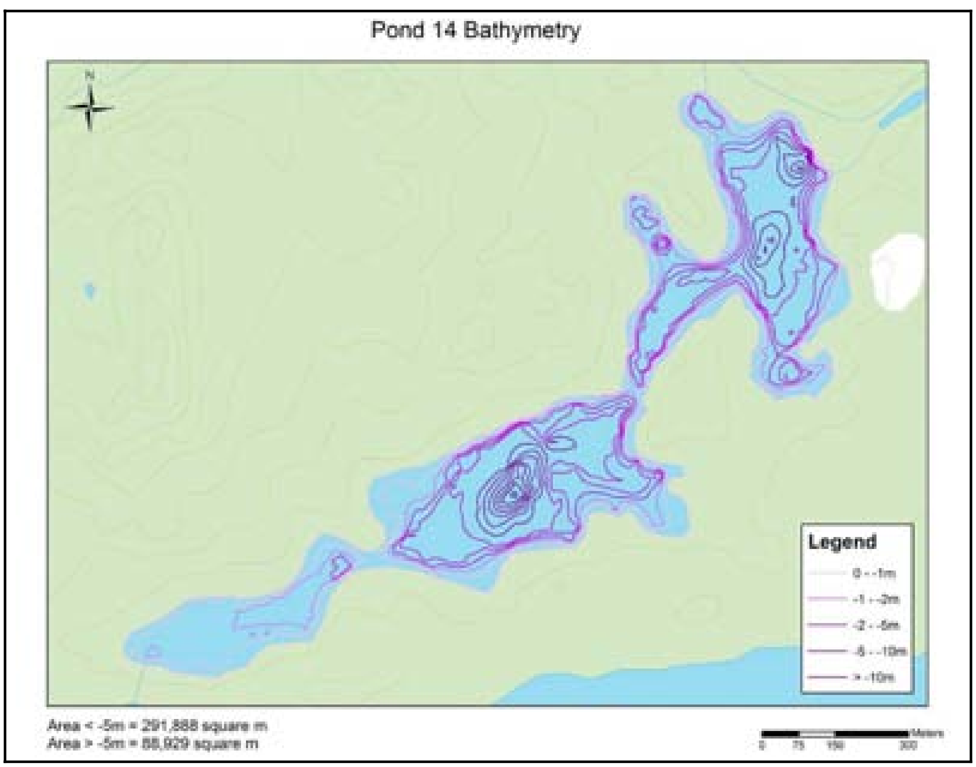


Figure 2.18 Sam Howe's Pond (P14) Bathymetric Contours, May 9, 2007

Table 2.9 Summary of Calculated Total Areas of Each Habitat Type within Ponds of Rattling Brook

HABITAT TYPE	Area (Hectares)						
	P8 (Rattling Brook Big Pond)	P14 (Sam Howe's Pond)	Pond P22	Pond P23	Pond P24	Pond P25	Pond P30
P - Profundal Zone	106.19	8.89	0.00	0.37	0.00	0.00	0.00
Lc - Littoral Zone - Coarse	32.02	9.72	0.14	0.87	0.09	0.22	0.46
Lm - Littoral Zone - Medium	8.40	12.46	0.46	0.84	0.04	0.03	0.74
Lf - Littoral Zone – Fine, no aquatic vegetation	39.64	7.01	0.03	0.17	0.00	0.55	0.00
Lf – Littoral Zone – Fine, with aquatic vegetation	3.05	0.00		0.60	1.21	0.27	3.02
Sub Total, Littoral Zone	83.10	29.19	0.55	2.48	1.34		4.22
Total Habitat	189.29	38.08	1.18	2.85	1.34	1.07	4.22

Key: Littoral Coarse (comprising a majority of bedrock, boulder)
Littoral Medium (comprising a majority of rubble, cobble and gravel)
Littoral Fine (comprising a majority of sand and organics/detritus)
Profundal (comprising a majority of organics/detritus)

Ponds P22 and P23

Ponds P22 and P23 are small water bodies located at the headwater of Tributary T1-1-1 (Figure 2.6). They have total surface areas of 1.18 and 2.85 ha respectively. Both are in a high plateau with low ridges to the north, rising 20 m above the ponds.

Pond 22 extends at a general elevation of 135 m asl. The average depth of light penetration within the water column extends to the bottom of the pond (0.9 m depth). The pond is therefore comprised of littoral habitat only, with a substrate dominated by fines (organics and detritus) with gravel, cobble and boulders along the shoreline. The pond has emergent vegetation everywhere muck/detritus is present. Table 2.9 summarizes the fish habitat types within Pond P22.

Pond 23 is just downstream at a general elevation of 133 m asl. The average depth of light penetration was determined to be 1.05 m with a maximum pond depth of 3.4 m. The pond has a littoral zone comprising fines (organics and detritus) with some larger substrates around the shoreline. The profundal zone is entirely fines (organics and detritus). Emergent vegetation is present/visible throughout. Total littoral and profundal habitat surface areas are 2.48 and 0.37 ha respectively. Table 2.9 summarizes the fish habitat types within Pond P23.

Ponds P24 and P25

Ponds P24 and P25 are located on a high plateau at the headwaters of Beaver Brook (T1-1) (Figure 2.6). They have total surface areas of 1.34 and 1.07 ha respectively.

Pond P24 is at a general elevation of 105 m asl. The average depth of light penetration was to the bottom of the pond (1.0 m depth). The pond is therefore comprised of littoral habitat only with a substrate comprising a majority of fines (organics and detritus) with boulders present along the shoreline. It has emergent vegetation everywhere muck/detritus was present. Table 2.9 summarizes the fish habitat types within Pond P24.

Pond P25 is just downstream of Pond P24 at a general elevation of 100 m asl. The average depth of light penetration was 3.35 m with a maximum pond depth of 4.41 m. The pond is comprised of littoral habitat only, with substrate comprising a majority of fines (organics and detritus) and larger boulders around the shoreline. Emergent vegetation is present/visible throughout. Table 2.9 summarizes the fish habitat types within Pond P25.

Pond P30

Pond P30 is on the main stem of Rattling Brook just downstream from Sam Howe's Pond (P14) at a general elevation of 88 m asl. It has a total surface area of 4.22 ha.

The average depth of light penetration within the water column was 2.65 m with a maximum pond depth measured at 3.9 m. As classified for DFO habitat quantification, the pond is comprised of littoral habitat only, with a substrate comprising a majority of fines (organics and detritus) with boulder, cobble and rubble along the shoreline. It has emergent vegetation everywhere muck/detritus was present. Table 2.8 summarizes the fish habitat types within Pond P30.

Water Resource Use

The watershed was used in the past as a fresh water source for the AWA plant. While exact volumes extracted are not readily available, several sources have identified water consumption for the plant.

Idler (1969), reported total effluent flows at 8000 USGPM (i.e., 0.505 m^3/s). ERCO (1967) indicated the total discharge from the boiler house was 7000 USGPM (i.e., 0.442 m^3/s). As a conservative estimate, the latter value has been used to characterize past water extraction rates. The effects of this rate of water extraction on the natural hydrograph of Rattling Brook are shown in Figure 2.19. The resulting flow reduction would have reduced the available fish habitat within the watershed by restricting the amounts of suitable riverine habitat for most of the year, particularly in summer and mid-winter.

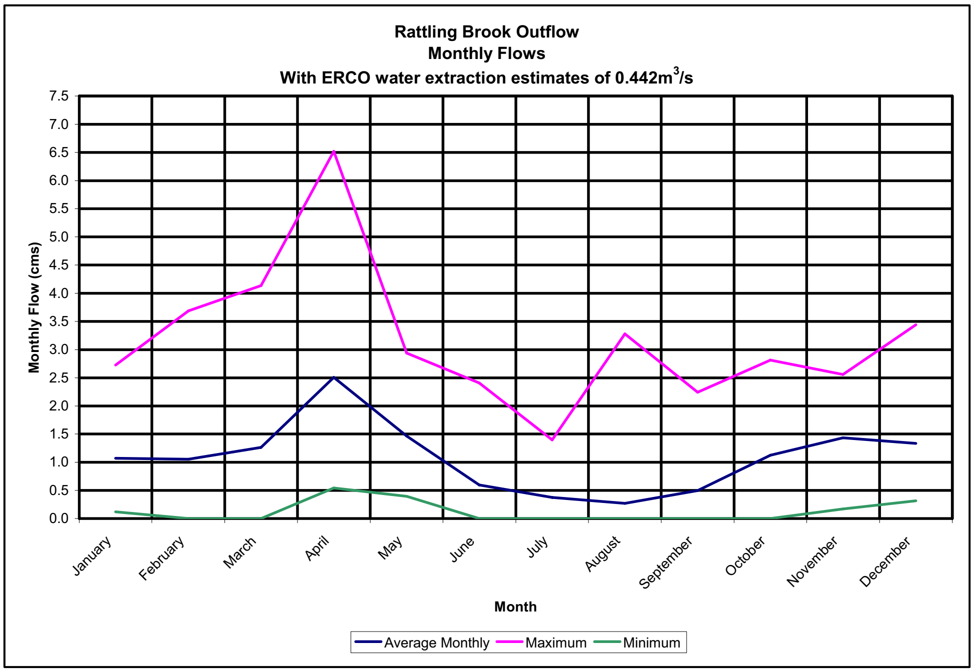


Figure 2.19 Hydrograph of Rattling Brook with Estimated Water Extraction for the Former Phosphorus Plant

2.3.4 Sandy Brook (S26)

Sandy Brook is located just east of Rattling Brook and also drains to the south side of Long Harbour. The watershed extends inland approximately 3.0 km and contains one large waterbody, Sandy Pond, (P15) as well as two smaller ones (Ponds P26 and P27 – Figure 2.6). The drainage area of Sandy Brook is approximately 4.8 km^2 with approximately half of the drainage coming from the outflow of Sandy Pond (2.3 km^2). Figure 2.6 presents the Long Harbour area and the stream drainage basin boundaries of Sandy Pond. Species within the watershed are brook trout, rainbow smelt and American eel.

Main Stem

The main stem is 2.36 km between its mouth at Long Harbour and Sandy Pond. The brook is identified as intermittent on provincial 1:50,000 topographic mapping. The main stem has extensive riparian vegetation with large woody debris throughout the upper reaches. Two reaches were dry during the surveys and flow appeared to go underground. Five cascade sections form obstructions under most flows. The substrate composition is primarily boulders and rubble throughout, with limited gravels and sand in the lower reaches. Brook trout and American eel were captured in the stream.

The Beak habitat classification quantifies the brook as a total of 22.94 units of Type II (rearing), 28.18 units of Type III (migratory) and 26.5 units of Type IV (pool) habitat. The proposed DFO Classification System identifies a total of 26.28 units of Riffle, 16.63 units of Pool, 1.50 units of Rapid, 15.65 units of Steady, 20.98 units of Cascade, and 1.10 units of Run habitat types. There was also 4.28 units of unwetted streambed. Flows at the time of the survey were high due to heavy rains; as a result, the measured habitat units are overestimated.

Hydrology

The natural hydrology of Sandy Brook has been established by pro-rating past records of nearby gauging stations. Figure 2.20 presents the hydrographs for a typical, dry and wet year. Figure 2.21 presents the flow duration curve.

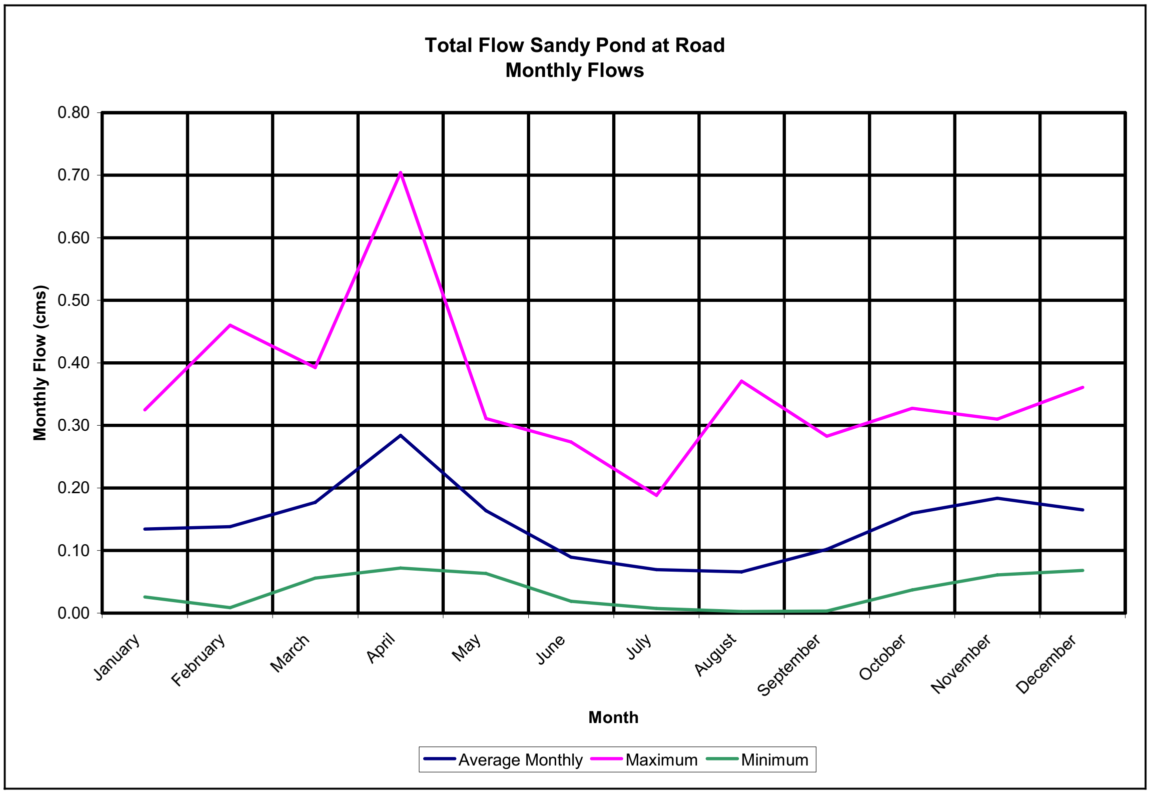


Figure 2.20 Hydrographs (Typical, Wet and Dry Year), Sandy Brook Outflow

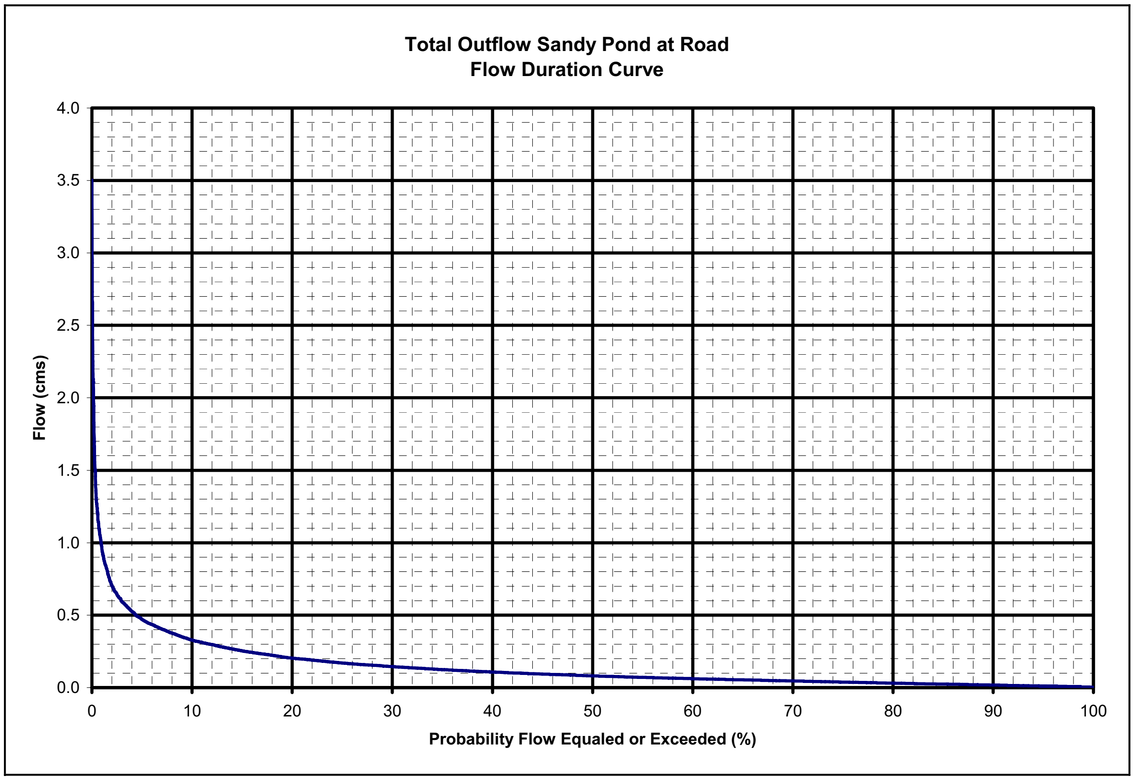


Figure 2.21 Flow Duration Curve, Sandy Brook Outflow

Tributary to Sandy Brook

There is a small intermittent sub-tributary that drains into the main stem of Sandy Brook approximately 1.5 km upstream from Long Harbour. The pro-rated hydrology of the brook presented below (Figure 2.22) shows its low flows; however, it provides about one-third the mean annual flow to Sandy Brook below its confluence.

Sandy Brook Lacustrine Habitat

Three waterbodies within Sandy Brook may be affected by the Project - Sandy Pond, Pond P26 (Moore's Pond) and Pond P27 (Figure 2.6). Summary habitat descriptions are provided below. Additional habitat quantification details are provided in the Freshwater Component Study (AMEC 2007a).

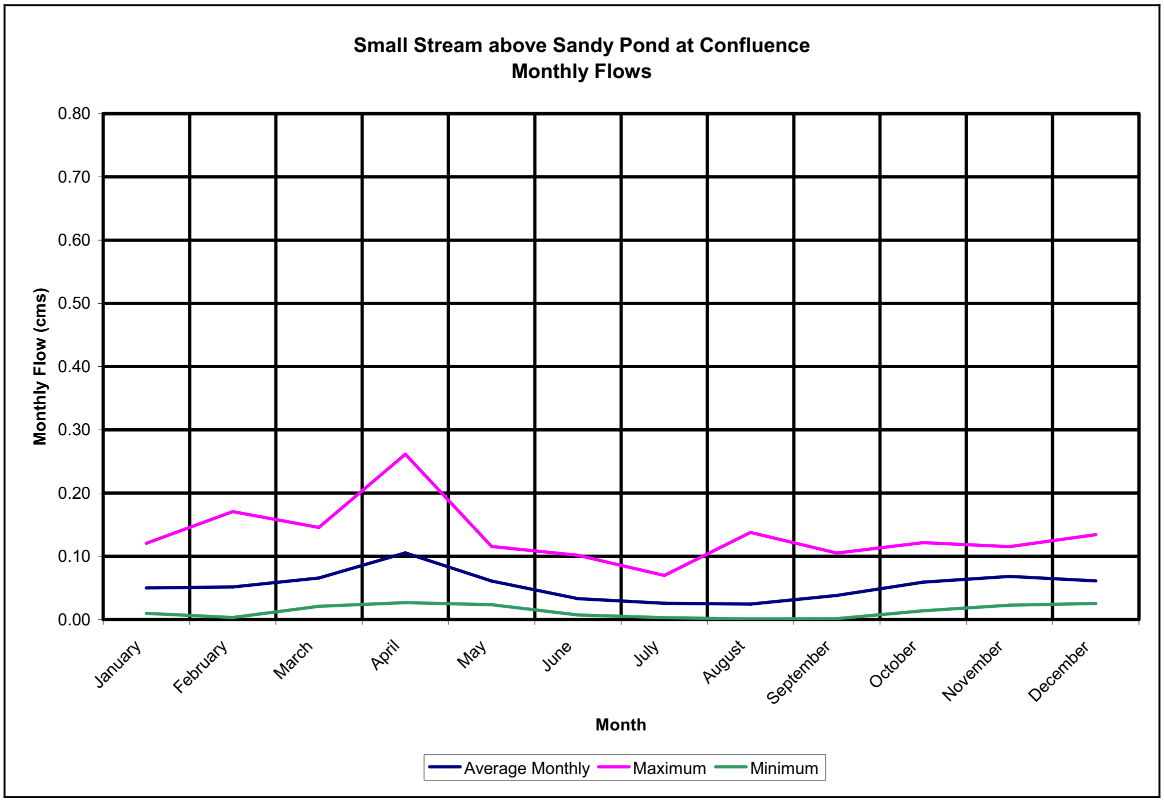


Figure 2.22 Hydrographs (Typical, Wet and Dry Year), Sandy Brook Tributary

Sandy Pond (P15)

Sandy Pond (P15) has a total surface area of 37.83 ha. It is at a general elevation of 100 m asl in a forested valley with ridges surrounding the entire pond between 150-180 m asl. The average depth of light penetration was determined to be 2.9 m with a maximum pond depth of 16.5 m. The shoreline comprises a majority of boulders and rubble with the deeper zones comprised of fines (organics and detritus). The pond has emergent vegetation at the eastern end. Figure 2.23 presents the bathymetric contours of P15 as modelled from the data. The total littoral and profundal habitat surface areas are 13.91 and 23.92 ha respectively. Table 2.10 below summarizes the fish habitat types.

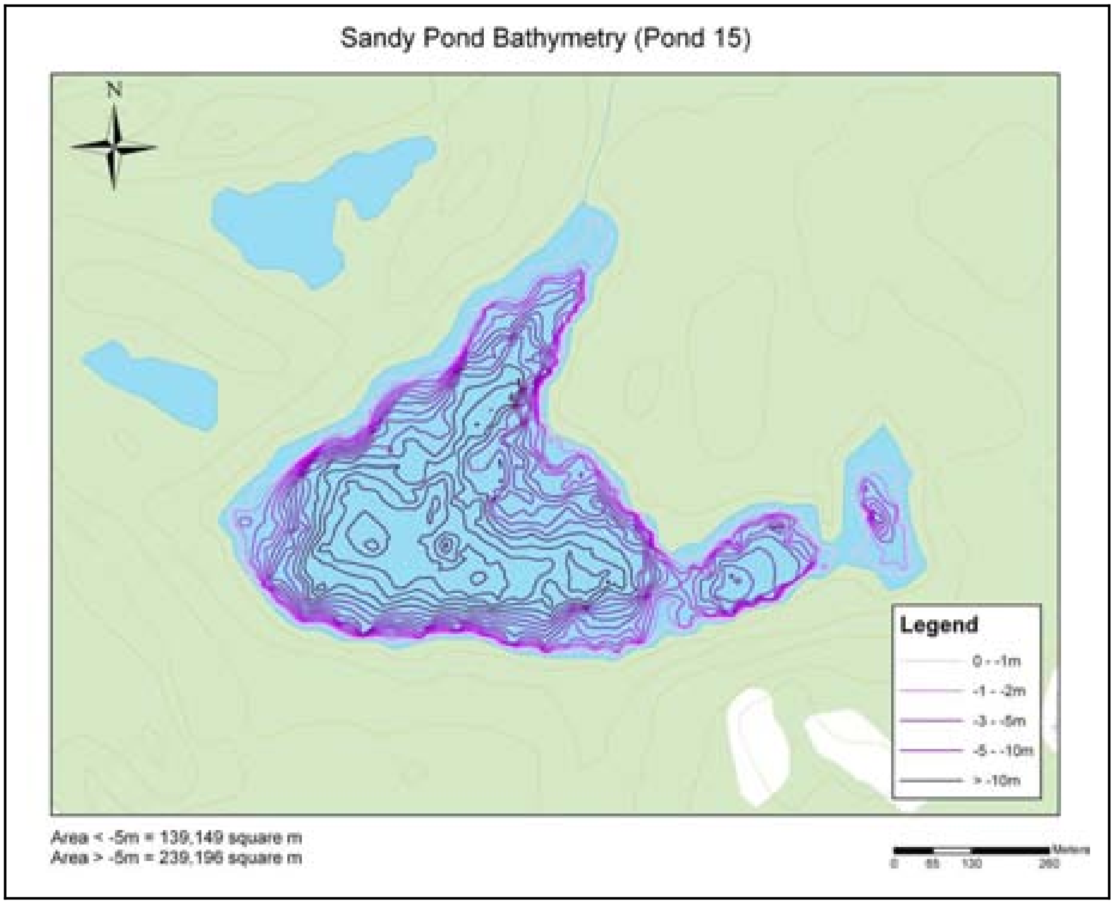


Figure 2.23 Sandy Pond (P15) Bathymetric Contours, August 17, 2006

Table 2.10 Summary of Calculated Total Areas of Each Habitat Type for Ponds in Sandy Brook Watershed

HABITAT TYPE	Area (Hectares)	
	Sandy Pond	**Pond P27**
P - Profundal Zone	23.92	0.54
Lc - Littoral Zone – Coarse	3.35	0.48
Lm - Littoral Zone – Medium	1.90	0.18
Lf - Littoral Zone – Fine, no aquatic vegetation	8.44	0.41
Lf – Littoral Zone – Fine, with aquatic vegetation	0.22	0.01
Sub Total, Littoral Zone	13.91	1.08
Total Habitat	37.83	1.62

Key: Littoral Coarse (comprising a majority of bedrock, boulder)
Littoral Medium (comprising a majority of rubble, cobble and gravel)
Littoral Fine (comprising a majority of sand and organics/detritus)
Profundal (comprising a majority of organics/detritus)

Ponds P26 and P27

Two small water bodies lie at the headwater of Sandy Brook just to the northwest of Sandy Pond. Both are at a general elevation of 120 m asl, on an exposed bedrock plateau with some forested shoreline. The total surface areas of P26 and P27 are 4.10 and 1.62 ha respectively.

Pond 26 has an average depth of light penetration within the water column of 2.90 m with a maximum pond depth of 4.32 m. The pond has a shoreline of boulders, rubble, cobble and bedrock. Gravels are also present as well as muck/organics. Limited emergent vegetation is present/visible. Figure 2.24 presents the bathymetric contours of P26 as modelled from the data. No fish were captured, and therefore it is not considered fish habitat.

Pond 27 has an average depth of light penetration within the water column of 1.35 m with a maximum pond depth of 7.48 m. The shoreline is boulder-cobble. The deeper portion of the littoral zone and the profundal zone is composed primarily of organics and detritus, with limited emergent vegetation present/visible throughout. The total littoral and profundal habitat surface areas are 1.08 and 0.54 ha respectively. Figure 2.25 presents the bathymetric contours of P27 as modelled from the data. Table 2.10 summarizes the fish habitat types within the pond. Brook trout were the only species captured.

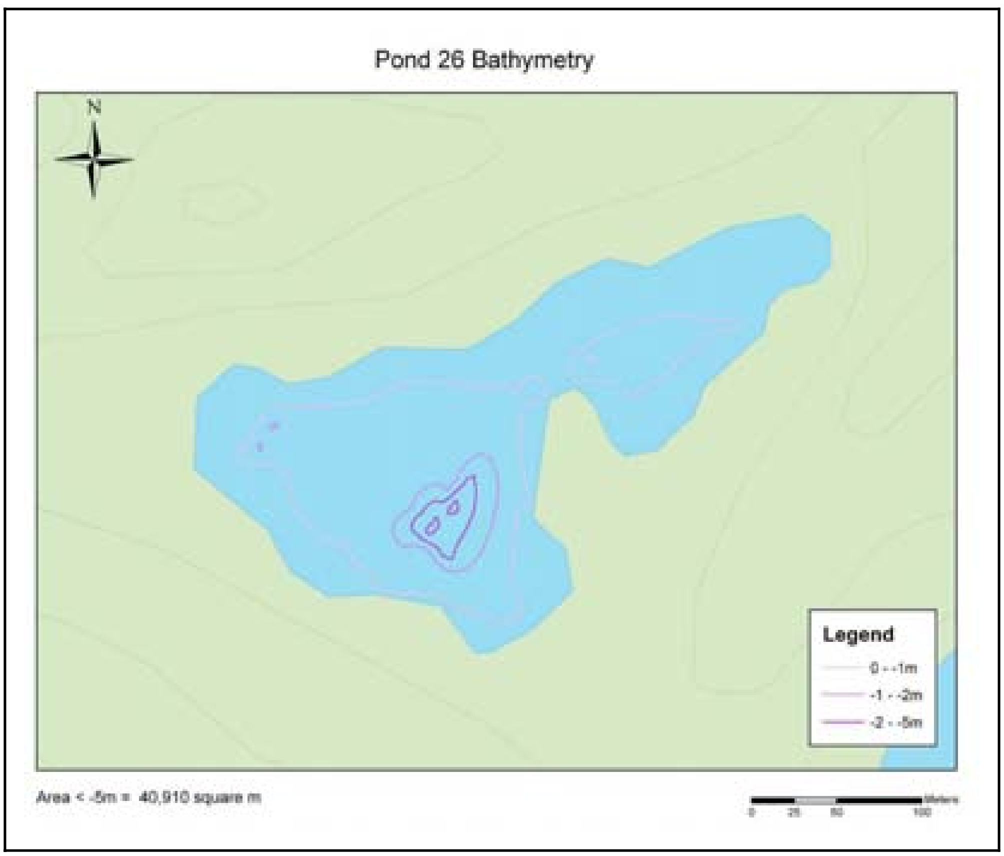


Figure 2.24 Pond P26 Bathymetric Contours, July 2, 2006

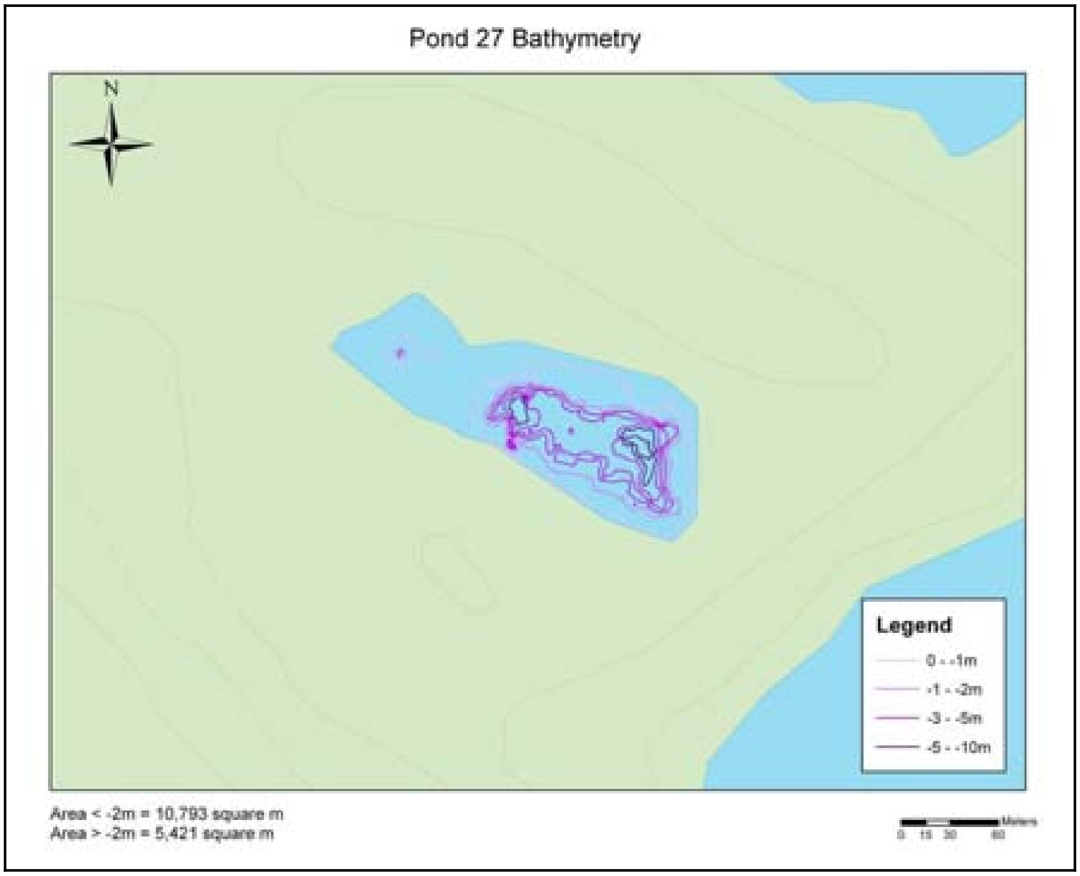


Figure 2.25 Pond P27 Bathymetric Contours, June 30, 2006

Sandy Pond Water Resource Use

The Sandy Pond watershed is undeveloped with no cabins or roads. It is, however a local destination for brook trout fishing, and discussions with local residents and anglers indicate that fish can be larger than those typically found in the surrounding ponds. This may be due to the presence of rainbow smelt as a food source. An existing trail from Highway 101 to Sandy Pond is used by anglers to access the pond, mostly during winter, as it is easier to access. While sought for angling, the fish are not preferred for eating since their flesh is pale and of poor quality and taste.

2.3.5 Little Rattling Brook (S33)

Little Rattling Brook (T3) is located to the west of Rattling Brook and drains to Ship Harbour (Figure 2.6). This small watershed (approximately 8.55 km^2) is identified as intermittent on available 1:50,000 topographic maps. The brook is approximately 1.6 km in length and has a complete obstruction approximately 500 m upstream from Ship Harbour (Porter et al. 1974). The pro-rated hydrology presented below (Figure 2.26) shows its intermittent nature in summer low flow periods.

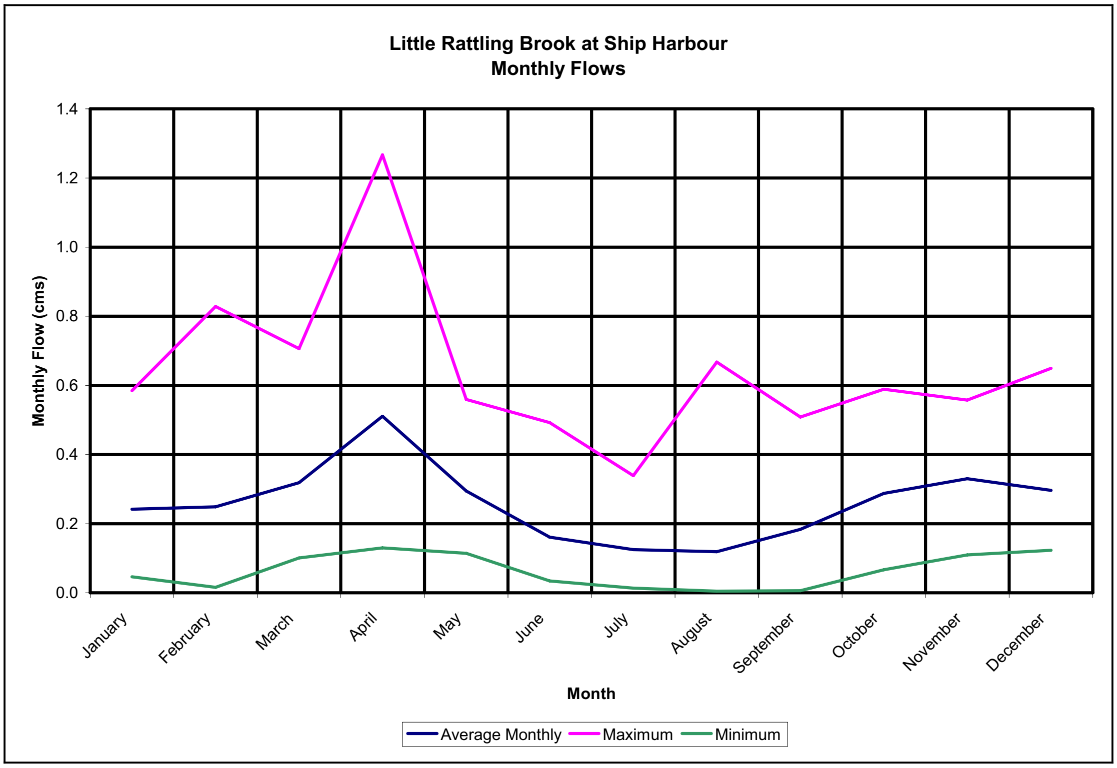


Figure 2.26 Hydrographs (Typical, Wet and Dry Year), Little Rattling Brook Outflow

2.3.6 Freshwater Fish

The following sections are based on a review of information and field surveys conducted by AMEC (2007a) and describe the freshwater fish (including anadromous and catadromous species) present in watersheds of the Project site.

Fish species recorded during the VBNC studies in the proposed Project Area include brook trout (*Salvelinus fontinalis*), Arctic charr (*Salvelinus alpinus*), rainbow smelt (*Osmerus mordax*) and American eel (*Anguilla rostrata*). Several DFO documents summarize the general biology of each species for use in habitat quantification (see Bradbury et al. 1999a; Grant and Lee 2004). Each species is listed below with a brief life history description from these documents. It is interesting to note that no stickleback species were captured within the Study Area.

Brook Trout

Brook trout are widely distributed throughout Newfoundland and Labrador and are thought to exist in all Newfoundland freshwater ecosystems, where they have been reported to make extensive use of lake habitats. They can be either landlocked or anadromous, spending one or two months feeding at sea in relatively shallow water close to their natal stream. There is also evidence to suggest that two forms of brook trout may coexist in some Newfoundland lakes: a primarily benthic feeding population that is relatively slow growing and short-lived, and a larger-bodied, piscivorous population that is faster growing and longer-lived. Optimal riverine habitat is characterized as clear, cold spring-fed water with silt-free rocky substrate in riffle-run areas; well vegetated stream banks; an approximate 1:1 pool-riffle ratio with areas of slow, deep water; abundant instream cover; and relatively stable water flow, temperature regimes, and stream banks.

Spawning normally occurs between late September and early November in shallow, gravel-bottomed streams and occasionally in lakes at depths less than two metres. Although growth rates are variable brook trout usually mature at two to four years of age. Although they seldom live longer than five or six years, they have been reported from several Newfoundland lakes up to eight years of age.

Brook trout often seek refuge among rocks, aquatic vegetation, woody debris, overhanging logs and undercut banks. They are common in the Project Area and environs and are the target of recreational fishing.

Arctic Charr

The Arctic charr has the most northerly distribution of any freshwater fish and is distributed throughout Newfoundland and the entire Labrador coast, and may be classified as either anadromous or resident freshwater populations. They are common in certain areas of the province and may be the dominant species in some lakes.

In Newfoundland, landlocked Arctic charr may spawn in streams or lakes from early October to mid-November. Preferred habitat is usually gravel/cobble substrate at depths of 1-5 m, which are sufficient to keep eggs safe from winter ice.

In Newfoundland lakes, Arctic charr (age 4+ to 9+) have been found predominantly in the pelagic zone during June and July, while occupying mainly benthic habitat during other times of the year. Within lakes, some part of the adult population usually performs a seasonal movement from the benthic to the pelagic zone in response to improved food abundance during late summer in the form of high crustacean zooplankton density.

Arctic char are scarce in the Study Area and were only found in Rattling Brook Big Pond.

Rainbow Smelt

Rainbow smelt may occur in both anadromous and landlocked forms. Landlocked populations may exist as either normal or dwarf-sized forms, and have been reported throughout many parts of insular Newfoundland. It has been assumed that both have similar habitat requirements.

On the Avalon Peninsula, landlocked rainbow smelt have been observed spawning in lakes before ice-out in early to mid-April, while spawning in tributary streams did not occur until early to mid-May, after ice had moved out. Eggs are released indiscriminately over a wide variety of substrates including mud, clay, sand, gravel, cobble, rubble, boulders and aquatic vegetation at depths ranging from 0.1 to five metres. Rainbow smelt mature at 1-2 years.

The only pond in the Study Area found to contain smelt was Sandy Pond. Local fishers believe that trout in this pond are relatively large due to their diet of smelt; however, catches are not often eaten because of the poor taste and flesh colour.

American Eel

The American eel is distributed from the southern tip of Greenland, southward along the Atlantic coast and the Gulf of Mexico to the northern portion of the east coast of South America. They have been reported throughout Newfoundland and the southeastern coast of Labrador as far north as Hamilton Inlet. The American eel is catadromous spending most of its life in freshwater and estuaries but migrating to sea to spawn. Eels typically begin their spawning migration in late summer and fall throughout much of eastern Canada, although migration from lakes that are far inland may begin earlier. Peak migratory activity often occurs in September-October during the last quarter of the moon, and is enhanced by dark, stormy nights and rising water levels.

Eels spawn in the Sargasso Sea, with peak spawning occurring in between January and March, but sometimes extending to May or June. Although spawning depth is not known, evidence suggests it in the upper few hundred metres of the water column. Adult eels presumably die after spawning.

During the freshwater phase of their life history, eels move into streams, rivers, and muddy or silt-bottomed lakes, generally following the bank of the river in very shallow water. They can be very mobile and may gain access to ponds and lakes, that appear unavailable to them by using very small watercourses or by moving overland through wet grass. Being nocturnal, they usually spend the day hiding under rocks and logs or buried in the mud. Investigations on diet composition of juvenile eels suggest that they rely heavily on benthic organisms and demersal fishes as food sources. Eels migrate to sea after spending twelve to thirteen years in fresh water, though there are indications that a proportion may remain in brackish estuaries and not enter freshwater at all.

Rattling Brook

Fish species recorded in the Rattling Brook watershed during 2005-2006 investigations include brook trout, Arctic charr and American eel (AMEC 2007a). This composition is supported by past reports (Albright and Wilson 1992), which confirm that the primary fish species in the surrounding watersheds is brook trout. Atlantic salmon do not the use watersheds near the Project site, and there are no reports of ouananiche (landlocked salmon) presence in the ponds. Arctic charr have been occasionally taken from Rattling Brook Big Pond and were determined by DFO to be residents (Albright and Wilson 1992). Brook trout are the primary fish species, occurring as resident populations throughout the ponds and streams within the watershed.

Brook trout numbers are relatively high with population estimates ranging between 9.98 and 48.68 individuals per unit (one unit =100 m^2). Biomass was also high (345.6 – 883.9 g/unit).

American eel were captured in low numbers (3) and only near the mouth of the main stem.

A single Arctic charr was captured in Rattling Brook Big Pond. Resident Arctic charr were previously identified (Albright and Wilson 1992).

Sandy Brook

Fish species recorded in the Sandy Pond watershed during 2005-2006 investigations included brook trout, American eel and rainbow smelt, a species composition is supported by past reports (Albright and Wilson 1992).

Brook trout were found in Sandy Pond (P15), Pond P27 and at stream electrofishing stations within the watershed. Numbers were relatively high with estimates ranging between 53.14 and 124.23 individuals per unit (one unit = 100 m^2). Biomass was also relatively high (427.5 - 1999.8 grams/unit).

American eels were captured in Sandy Brook and Sandy Pond, but not in Ponds P26 or P27. Rainbow smelt captured in Sandy Pond as well as a sub-sample of brook trout were submitted for stable isotope analysis. The results indicate that both populations are resident and non-anadromous.

Fish Species at Risk

Recent concern regarding population decreases in the Great Lakes has prompted the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to list the American eel as a *species of concern* in 2006 (COSEWIC 2006b). This designation is defined as a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats. The reason for the designation has been that indicators of the status of the total Canadian component of this species are not available. Indices of abundance in the Upper St. Lawrence River and Lake Ontario have declined by approximately 99% since the 1970s. The only other data series of comparable length (no long-term indices are available for Scotia/Fundy or Newfoundland and Labrador) are from the lower St. Lawrence River and Gulf of St. Lawrence, where four out of five time series declined. Because the eel is panmictic (i.e., all spawners form a single breeding unit), recruitment of eels to Canadian waters would be affected by the status of the species in the United States as well as Canada. Prior to their decline, eels reared in Canada comprised a substantial portion of the breeding population of the species. The collapse of the Lake Ontario-Upper St. Lawrence component may have significantly affected total reproductive output, but time series of elver abundance, although relatively short, do not show evidence of an ongoing decline. Recent data suggest that decline may have ceased in some areas; however, numbers in Lake Ontario and the Upper St. Lawrence remain drastically lower than former levels, and the positive trends in some indicators for the Gulf of St. Lawrence are too short to provide strong evidence that this component is increasing. Possible causes of the observed decline, including habitat alteration, dams, fishery harvest, oscillations in ocean conditions, acid rain, and contaminants, may continue to impede recovery. The designation as a *species of concern* does not engage any additional conservation measures outside those within the *Fisheries Act*. American eel has been found at several locations in the Study Area.

2.4 Marine Environment

This section concerns water and sediment chemistry, marine fish and fish habitat, marine-related avifauna including bald eagle, and marine-associated mammals including river otter. The related components, commercial fisheries and aquaculture, are contained in Volume 3 Effects Assessment-Socio-economic Environment.

2.4.1 Marine Ecosystem

Marine habitat can be defined as a set of physical, chemical and biological conditions that support the survival of a population of organisms. The organisms use that particular marine space for all or part of their life history for feeding, migration, refuge, and reproduction (Vandermeulen 2005).

According to the *Fisheries Act*, 'fish habitat' means spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.

There are a variety of fish habitat types in Placentia Bay. A relatively recent biological and geomorphological classification of Placentia Bay (Catto et al. 1999) identified five regional subdivisions of shoreline biological communities.

- The Cape Shore (Cape St. Mary's to northern tip of the Argentia Peninsula)
- Northeast Placentia Bay (northern tip of Argentia Peninsula to North Harbour)
- the Swift Current Estuarine Region (North Harbour to Prowsetown, including Sound Island, Woody Island, and Bar Haven Island)
- Northwest Placentia Bay (Merasheen Island, Long Island, the Ragged Islands archipelago, Isle Valen, Presque Harbour, Paradise Sound and the adjacent mainland shores of Newfoundland)
- The Burin Peninsula

The Project Area occurs in the subdivision of Northeast Placentia Bay. Biota along the shores are affected by the same north-flowing currents that influence the Cape Shore subdivision, but the shores of Northeast Placentia Bay are relatively more protected from surf and ice erosion by the highly convoluted and indented nature of the coast. Pack ice that enters the outer part of Placentia Bay rarely occurs north of the Argentia Peninsula (Catto et al. 1999).

Catto et al. (1999) also identified eleven biological shoreline units as components of the five regional subdivisions listed above.

- Saltmarsh
- Eelgrass
- *Fucus anceps* Surf Zone
- Seabird-Dominated Shores
- *Ascophyllum* Rockweed Shores
- Capelin Spawning Beaches
- Temporary Intertidal Communities
- Barachois Estuaries
- Vertical Biological Zones
- Rockweed Platforms
- Periwinkle Shores

Many of these biological shoreline units are discussed in more detail in this section in relation to fish and invertebrate habitat components (e.g., water and sediment quality, plankton, benthos) and important macroinvertebrates and fish.

Offshore habitat in Placentia Bay is less diverse than the nearshore habitat. Maximum water depth exceeds 250 m and bottom substrate varies from fine (mud/silt) to coarse (boulder/bedrock).

Marine Water Quality

Water quality relates to the composition of water as affected by natural processes and human activities. It includes not only chemical composition, but also biological and physical characteristics. The quality of water is also related to specific use, and is usually measured in terms of constituent concentrations. The primary role of seawater being considered here is its importance as a component of fish habitat.

Placentia Bay

This section discusses the chemical aspect of seawater quality as it pertains to Placentia Bay. The biological aspect will be discussed in subsequent sections.

Surface seawater samples were collected at 16 stations in the water column surrounding the Argentia Peninsula within the past 10 years (JWEL 1997; LGL 1998).

Long Harbour

Between October 2005 and October 2006, bottom and surface seawater samples were collected on four occasions at six locations within Long Harbour, and three times at a reference location (Little Seal Cove) immediately south of the harbour mouth (see Marine Component Study by LGL 2007).

Sampling stations provided coverage from the head of the harbour (Sandy Point) to the mouth (Shag Rocks). Water depths at the bottom sampling stations ranged from 7 to 18 m (LGL 2007).
Parameters measured in the sea water samples included pH, total suspended solids (TSS), benzene, toluene, ethylbenzene, xylene/total petrogenic hydrocarbons, mercury, and metals.

Concentrations were generally higher in surface and bottom sea water samples at stations in the inner part of Long Harbour (i.e., Sandy Point, Maturin Point, and The Key) than in the outer harbour or reference station. The TSS, arsenic, chromium, copper, iron manganese, and zinc concentrations were consistently higher in Long Harbour than at Little Seal Cove.

Surface seawater data were also collected at two stations in Rattling Brook Cove in December 2002 (JWEL 2003). Analytical results for samples collected by LGL (2007) between October 2005 and October 2006 at the stations nearest to Rattling Brook Cove (i.e., Maturin Point and The Key) were similar to the 2002 results. Notable differences included maximum concentrations of arsenic and copper that were noticeably higher in 2005-06 compared to 2002 results, and maximum concentrations of iron and manganese that were noticeably lower in 2005-06 compared to 2002 (LGL 2007).

Marine Sediment Quality

Marine sediments provide habitat for many benthic infauna and epibenthic organisms, which in turn interact with non-benthic marine organisms. Sediments also influence the environmental fate of many chemical substances in marine ecosystems by acting as both sinks and sources of substances that enter the marine environment.

Placentia Bay

Surficial sediments sampled at four locations in the inner part of Placentia Bay **(**Come by Chance refinery, Woody Island/Sound Island, Red Island, and Long Island) were analyzed for aromatic hydrocarbons (Kiceniuk 1992). Overall, the highest levels of bioavailable aromatic hydrocarbons were found in sediment collected at Woody Island/Sound Island and Port Royal Arm on the west side of Long Island.

Ramey and Snelgrove (2003) also collected surficial sediments in Placentia Bay: six stations in the inner part of the bay (H, C, W1, W2, E1, and E2) and one in the middle of outer Placentia Bay (O). Specifics of these samples are contained in Table 2.11.

Table 2.11 Surficial Sediment Analyses (Means) in Placentia Bay, 2003

Site	Depth (m)	Sand (%)	Silt (%)	Clay (%)	C (%)	N (%)	C/N
H	67	8	56	36	8.1	0.33	8.5
C	210	3	59	38	6.6	0.91	9.1
W1	214	3	42	55	7.8	1.115	8.8
W2	283	3	56	41	5.3	0.64	9.0
E1	225	2	64	34	6.2	0.77	8.6
E2	217	3	52	45	4.8	0.61	9.2
O	230	22	67	11	1.3	0.15	8.3
Source: Ramey and Snelgrove (2003).							

These data provide an example of the difference between inner Placentia Bay deep surficial sediments and those in the outer bay. Sediments sampled at the inner Placentia Bay locations were characterized by higher proportions of clay, carbon and nitrogen.

Surficial sediment quality was also examined at five stations during a survey of benthic conditions at Whiffen Head in the 1990s (JWEL 1996b). Approximate water depths ranged from 5 to < 20 m. No detailed particle size analysis results were presented in the report. One station was in sand/cobble habitat and the other four were in cobble/boulder habitat. Analyses were conducted for twenty-two inorganic analytes. The mean levels of four inorganic analytes (arsenic, copper, nickel and vanadium) exceeded either the respective guideline values for Ocean Dumping or threshold effect level (TEL) established by Environment Canada at one station (10-20 m depth; cobble/boulder habitat). None exceeded the respective probable effect level (PEL) established by Environment Canada, the concentration at which adverse effects on aquatic life are occasionally expected to occur.

Long Harbour

Surficial marine sediment samples were collected on four occasions at six locations within Long Harbour, and three times at a reference location immediately south of the harbour mouth between October 2005 and October 2006 as part of the Marine Component Study (LGL 2007). A single sediment sample was also collected at a location between Shag Rocks and Crawley Island at a depth of 69.5 m. Sampling stations within Long Harbour provided coverage from the head of the harbour (Sandy Point) to the mouth (Shag Rocks). Water depths ranged from 7.5 to 70 m. Surficial sediments with high proportions of fines were targeted (LGL 2007).

Parameters measured in the surficial marine sediment samples included particle size, total inorganic carbon/total inorganic carbon, extractable hydrocarbons ($>C_{10}$-C_{32}), sulphate, mercury, and available metals.

Similar to the water analyses, stations in the inner part of Long Harbour, particularly at Sandy Point and Maturin Point, generally exhibited higher concentrations of some parameters than the outer stations. Concentrations at the stations within Long Harbour were consistently higher than those at the reference station at Little Seal Cove. Exceptions to this included C_{10}-C_{21} hydrocarbons, strontium and thallium (LGL 2007).

None of the surficial sediment samples collected between October 2005 and October 2006 exceeded any of the available PEL (probable effects level) guidelines. All exceedances were related to Interim Sediment Quality Guidelines (ISQG), which are more conservative than the PEL guidelines and do not have as strong a biological basis (LGL 2007).

Marine sediment data were collected at two stations in Rattling Brook Cove in December 2002 during a previous baseline investigation for VBNC (JWEL 2003). Recent surficial sediment sampling was also conducted in the vicinity of the wharf in Long Harbour (JWEL 2003; AMEC 2006).

The surficial sediments collected at the two 2005-2006 stations nearest to Rattling Brook Cove (i.e., Maturin Point and The Key) had higher maximum levels of many parameters compared to sediments collected in 2002. These parameters included sulphate, mercury, C_{21}-C_{32} TPHs, arsenic, barium, chromium, copper, iron, nickel and vanadium. Marine sediments collected in December 2002 were much coarser than those collected at the Maturin Point and The Key stations during the 2005-2006 baseline study. The 2002 marine sediment samples were primarily composed of gravel and sand and the fines component never constituted more than 4%. The higher proportion of fines in the 2005-2006 samples likely contributed to the higher levels of some metals and hydrocarbons in surficial sediments compared to the earlier results.

Four marine surficial sediment samples were collected along the edges of the wharf in Long Harbour in July 2006 (AMEC 2006). Generally, levels of many parameters were higher in the sediments collected at the wharf than in those collected at the Maturin Point and The Key stations. Parameters with noticeably higher maximum concentrations in the wharf sediments include C_{21}-C_{32} TPH, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, and zinc. The maximum available phosphorus concentration found in sediments from Maturin Point and The Key stations was 9000 mg/kg. The total phosphorus found in the wharf sediments ranged between 18,100 and 86,200 mg/kg.

Plankton

Chorophyll a, a measure of phytoplankton standing crop, was measured in water samples collected at seven locations in Placentia Bay in June and August 1998 (Ramey and Snelgrove 2003). Samples were collected at 5 m depth in six locations in the inner part of the bay and one in the central part of the outer bay. In both June and August, *chlorophyll a* concentrations were generally higher in inner Placentia Bay than at the outer location. The innermost stations had the highest *chlorophyll a* concentrations. Ramey and Snelgrove (2003) indicated that these trends were consistent with those indicated by the Sea-Viewing, Wide-Field of-View Sensor Spacecraft (SeaWiFS) in April, July and September of that same year. Overall, *chlorophyll a* concentration was highest in April.

DFO Newfoundland Region has conducted zooplankton sampling (including icthyoplankton) in Placentia Bay. Fish stomach analysis also provides information on zooplankton. The diet of capelin captured within Placentia Bay in January and May-June 1999 was investigated by O'Driscoll et al. (2001). Sampling sites were located in inner and outer areas of the bay during both sampling times. *Temora* spp. and *Metridia* spp. were the most abundant copepods in diet of capelin collected in January. The proportion of *Calanus* spp. in the diet increased in the spring (May-June). Larger capelin caught in Placentia Bay in spring fed mainly on *hyperiid* amphipods.

The seasonal diet of Atlantic cod in Placentia Bay was investigated during the 1997-2000 period. Planktonic invertebrates identified in the cod stomachs included various amphipods, cnidarians and copepods (Mello and Rose 2005a).

Ichthyoplanton is defined as the free floating stages of certain species of fish eggs and larvae. Distribution information on the pelagic eggs of American plaice, Atlantic cod and cunner (*Tautogolabrus adspersus*) has been compiled by Bradbury et al. (2003). Plaice and cod eggs were found in highest abundance on the west side of Placentia Bay, particularly in the vicinity of Bar Haven Island and off the southern Burin Peninsula. A notable abundance of Stage II eggs of both American plaice and cod was also found immediately southwest of Merasheen Island. Cunner eggs were distributed more widely, occurring primarily in waters proximate to Marystown, between Marystown and Paradise Sound, off Cape Shore, offshore of Paradise Sound, and extensively throughout the large islands of inner Placentia Bay.

Bradbury et al. (2003) also provide distributional information on the larvae of Atlantic cod, cunner, capelin and sand lance (*Ammodytes* sp.) based on field sampling in June and August 1998. Cod larvae were most abundant in western waters off the Burin Peninsula, cunner larvae in the inner part and off the southern Burin Peninsula, Capelin larvae in western waters off the southern Burin Peninsula and in the waters around southern Merasheen Island and Red Island. Sandlance larvae were most abundant in waters off the Cape Shore, in the central part of outer Placentia Bay, and off the southern Burin Peninsula. Cod larvae were the least abundant of the four species. Patchiness in distribution generally increased during development of all three species with pelagic eggs (i.e., Atlantic cod, American plaice, and cunner). Larval patchiness was initially high at hatch, decreased strongly post-hatch, and subsequently rose sharply. The range of estimated patchiness during development was highest for pelagic schooling species with demersal eggs (i.e., capelin, sandlance) (Bradbury et al. 2003).

Spatial distribution patterns during the egg and early larval period of cod, American plaice, and cunner were consistent with passive transport out of the western side of the bay following spawning near the head. Bradbury et al. (2003) hypothesized that observed spatial patterns in older larvae, seasonal size increases in larvae from demersal eggs, and ontogenetic changes in patchiness reflect active processes-in other words, larger larvae may actively contribute to changes in their spatial distribution. The authors concluded that swimming ability and behaviour become increasingly important in determining spatial distribution patterns as pelagic larvae develop.

Ichthyoplankton surveys during the spawning and postspawning seasons of 1997 and 1998 indicated that Atlantic cod egg densities were highest during early spring of both years, subsequently decreasing during spring and summer (Bradbury et al. 2000). The distributions of different egg development stages and larvae of varying size suggested that the eggs and larvae were released from spawning locations and developed as they were transported in cyclonic flow from the southeast and around the bay towards the southwest. This is in agreement with the results of the VBNC oceanographic studies and others that suggest that the water currents generally flow counter-clockwise in Placentia Bay. During the two years of study, Stage I cod eggs were concentrated in three areas: Perch Rock, southeast outer bay; Bar Haven, northwest inner bay; and Oderin Bank, western outer bay. The data indicated that substantial inshore cod spawning occurs at spatially consistent sites in Placentia Bay. The reasons for this are still unclear, although algal biomass is typically highest at the head and western side of the bay, thereby perhaps providing greater food resources for hatching larvae.

Bradbury et al. (2001b) suggested that the effects of predation on cod egg mortality are small relative to the advective effects within the Placentia Bay system, and that the interaction between advection and temperature-dependent vital rates of eggs may have dramatic consequences for coastal retention of eggs and larvae produced within the bay.

Marine Benthos

The term "benthos" refers to those plants and animals that live on or in the seabed. The community is composed of many of taxonomic groups, from algae to flounder, that use a wide variety of feeding modes. A study conducted in the 1970s identified 84 gammaridean and two caprelliad amphipod species in Placentia Bay (Fenwick and Steele 1983).

The first major study on sedentary macrofauna in muddy substrates in Placentia Bay was conducted in 1998 (Ramey and Snelgrove 2003). Benthic macrofauna was sampled at seven locations within Placentia Bay, six at depths within a 210 to 230 m range, and the other at 67 m (Ramey and Snelgrove 2003). Six of the sampling stations were located in the inner part of Placentia Bay north of latitude 47º 25'N (shallowest one at the head of Placentia Bay inside of Bar Haven Island [H], two in the Western Channel between mainland and Merasheen Island [W1 and W2], two in the Eastern Channel between mainland and Long Island [E1 and E2], one in Central Channel between Merasheen Island and Long Island [C]), and one was near Oderin Bank [O] (latitude 47º 11'N). The six inner sampling stations were located from 0.6 to 4.0 km from the shoreline. The single outer station was located 23 km from the Cape Shore shoreline. E1 and E2 occur in Northeast Placentia Bay subdivision, H occurs in Swift Current Estuarine Region subdivision, and W1, W2 and C occur in the Northwest Placentia Bay subdivision.

Based on various statistical analyses, distinct infaunal communities occurred at H, C + W1 (most northerly), E1 + E2 +W2, and O. Highest macrofaunal density was found at O and the lowest densities at H and C + W1. Vertical distribution of macrofauna in samples collected at O was more extensive than that in samples collected in the inner part of Placentia Bay. In all cases, macrofaunal density was highest in the upper 3 cm fraction of sediment compared to the 3-10 cm fraction (Ramey and Snelgrove 2003).

In terms of species richness (i.e., number of species per station), all of the inner stations were less than the outer station. Within the inner stations, species richness was highest at the shallowest station (H) and least at the northernmost Western Channel station (W1). Shannon diversity H' was highest at H, O and C + W1, and lowest at E1 + E2 + W2 (Ramey and Snelgrove 2003).

The dominant taxa at the seven sampling stations included numerous polychaete species, the bivalve *Thyasira* sp. and various ribbon worm species (Nemertea). The amphipod *Byblis gaimardi* was found at the outer Placentia Bay station but not at the inner stations. The single most abundant polychaete species was *Cossura longocirrata*. The polychaete *Pectinaria granulata* was abundant at the shallow station H but was either rare or absent at all of the other stations. *Thyasira* sp. was most abundant at O, C and W2 (Ramey and Snelgrove 2003).

Ramey and Snelgrove (2003) suggested that broad-scale changes in sedimentary macrofaunal communities in Placentia Bay may be related to surface water characteristics such as *chlorophyll a* levels. Within the inshore stations, high levels of organic carbon influenced macrofaunal assemblages that were similar to those characteristic of organic-rich areas. Surface *chlorophyll a* concentration was positively correlated with sedimentary organic carbon, which was the most important predictor of infaunal abundance.

Marine benthic habitats in the vicinity of the Newfoundland Transshipment Terminal at Whiffen Head were assessed in 1996 (JWEL 1996b). The survey was conducted within an area of approximately 2 km^2 (~ 1.5 km shoreline x 1.25 km offshore) in shallow subtidal areas off six beaches and several deeper subtidal areas (10 to >20 m). Subtidal substrates were categorized by particle size, and characteristic macrobenthos were identified for each substrate category. Three substrates and their respective characteristic macrobenthos were identified.

- Sand/Cobble – sea urchins, sand dollars, scallops
- Cobble/Boulder – sourweed (*Desmarestia* spp.), coralline algae, sea anemones, mussels, sea urchins
- Boulder/Bedrock - rockweed (*Fucus* spp.), sea anemones, mussels, sea urchins, cunners

The shallow subtidal areas were predominantly boulder/bedrock and cobble/boulder habitats. The sand/cobble habitat was located primarily in areas where depth exceeded 10 m. The coarser substrate habitats were also common in the deeper subtidal area (JWEL 1996b). Other biota noted during the habitat survey at Whiffen Head included cord weed (*Chorda filum),* sea colander kelp (*Agarum cribrosum*), sea stars, winter flounder, yellowtail flounder, ocean pout, lumpfish and Atlantic cod (JWEL 1996b).

Subtidal marine sediment samples were collected at two locations near the Come-By-Chance refinery site in 1990 (Fox Head and Come-By-Chance Point within 5 km of the refinery site), at Bread Island (approximately 10 km from the refinery site), and at Bar Haven Island (approximately 15-20 km from the refinery site) (LFA 1991). Samples were collected at 6 and 12 m depths at each of the four locations. Average abundance of benthic fauna was higher in the deeper sediments. Polychaetes were the most abundant benthic invertebrate group in the shallow sediments, followed by molluscs, crustaceans, and echinoderms. The most abundant species in each of these four groups were capitellid thread worms (polychaetes), chitons and limpets (molluscs), amphipods (crustaceans), and sea urchins (echinoderms) (LFA 1991). Crustaceans were the most abundant benthic invertebrate group in the deep sediments, followed by molluscs, echinoderms and polychaetes. The most abundant species in each of these four groups were amphipods and copepods (crustaceans), chitons (molluscs), brittle stars (echinoderms), and clam worms and terebellid worms (polychaetes) (LFA 1991).

The seasonal diet of Atlantic cod in Placentia Bay was investigated during the 1997-2000 period. Many benthic invertebrates were identified in the cod stomachs, including various echinoderms, amphipods, molluscs, polychaetes, and decapods (Mello and Rose 2005a).

As mentioned in the section on marine sediment quality, the physical characteristics of surficial marine sediments in Long Harbour are diverse. Associated with this physical diversity is biological diversity. Although surficial marine sediment samples collected in Long Harbour between October 2005 and October 2006 were not analyzed in terms of infauna, Remotely Operated Vehicle (ROV) surveys in the area indicated a diversity of both infauna and epifauna. Soft-substrate areas surveyed were often characterized by burrowing molluscs and polychaetes, small shrimp-like crustaceans and flatfish (winter flounder, American plaice). Areas with harder substrates were characterized by kelp and filamentous algae, coralline algae, epibenthic bivalves (e.g., scallops, mussels), echinoderms (e.g., sea stars, sea urchins), anemones, and demersal fish (e.g., cod, cunner) (LGL 2007).

2.4.2 Long Harbour Benthic Habitat

In October 2006, ROV surveys were conducted to assess fish habitat at three areas within Long Harbour: deeper water area (60-74 m) between Shag Rocks and Crawley Island; the shallow water area (8-15 m) immediately adjacent to the north side of the former ERCO wharf; and a shallow water area (1-10 m) of Rattling Brook Cove on the south side of the wharf (LGL 2007). The following sections describe the results of these surveys.

Deep Water Area between Shag Rocks and Crawley Island

The dominant substrate type on transects surveyed in this area consisted of soft, silty sediment that readily re-suspends in the water column when disturbed. Water depths in this area ranged from 60 to 74 m. Fauna observed in the soft sediment regions of the candidate outfall area included winter flounder, American plaice, eelpouts (Zoarcidae), bivalves, seastars, brittlestars and small crustaceans (likely amphipods). Occasional boulder clusters were also observed. Biota associated with these clusters included sea anemones, sea urchins and sea stars. A rocky hump that tops off at about 60 m and is completely surrounded by the deeper soft sediment habitat appeared to be a productive area relative to the surrounding area, and biota included echinoderms (seastars, sunstars, and sea urchins), corals, sea anemones, crabs, and cod(LGL 2007).

North Side of Wharf

The predominant type of substrate indicated by transects surveyed on the north side of the former ERCO wharf consisted of hard sediments such as sand, gravel, cobble, and small boulder. Water depth of the surveyed area ranged from 8.5 to 14.5 m. Biota observed during the survey included clumps of kelp, areas of low-lying filamentous algae (red, brown, and green algae), cunner, winter flounder, sea stars, sand dollars, mussels, and amphipods. There also appeared to be considerable decomposition (probably kelp) occurring in this area. Close to the wharf, at the start of each transect, metal scraps and other industrial waste was abundant (LGL 2007).

Rattling Brook Cove

The dominant substrate type indicated by transects surveyed in Rattling Brook Cove consisted of hard sediments such as sand, gravel and cobble. Water depth of the surveyed area ranged from 0.2 to 9.1 m. Biota observed during the survey include low-lying filamentous algae (red, brown, and green algae), coralline algae, eelgrass, and Irish moss in the shallower areas, along with periwinkles, hermit crabs, rock crabs, scallops, sea stars, and sand dollars. No fish were encountered during the survey within Rattling Brook Cove (LGL 2007).

2.4.3 Macroinvertebrate and Fish Species

This section focuses on species with the highest profiles from both ecological and commercial perspectives. Invertebrates include snow crab (*Chionoecetes opilio*), American lobster (*Homarus americanus*), sea scallop (*Placopecten magellanicus*), Iceland scallop (*Chlamys islandica*) and blue mussel (*Mytilus edulis*). Finfish discussed include Atlantic cod (*Gadus morhua*), capelin (*Mallotus villosus*), Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), lumpfish (*Cyclopterus lumpus*), American plaice (*Hippoglossoides platessoides*), and winter flounder (*Pseudopleuronectes americanus*).

Snow Crab

Snow crab in Newfoundland waters typically occurs at depths ranging between 60 and 400 m on mud/gravel bottom. The commercial fishery for snow crab has generally been very lucrative since the groundfish moratorium in 1992, but recent years have seen a downward turn in the stock (DFO 2006a).

Spawning by snow crab typically occurs in the spring/early summer. The eggs are carried by the females until larval hatch during the summer months when water temperatures are appropriate for development. The larvae are pelagic and may remain in the water column for months. Eventually, the final larval stage drops to the bottom and continues development to maturity in the benthic habitat (DFO 2006a). After assuming the benthic habitat, snow crab feed on benthic organisms including polychaetes, echinoderms and molluscs (DFO 2006a).

American Lobster

The American lobster has a continuous distribution around the island of Newfoundland, occupying a relatively narrow band of rocky habitat over an approximate depth range of two to 40 m (Ennis 1984). The inshore lobster fishery is primarily conducted in areas with water depths of 15 to 20 m during spring and early summer and remains important for many fishers (DFO 2006b). Lobster mating typically occurs during the summer months, immediately after the female moults. Egg fertilization might not occur until late summer/fall, when the female carries the developing eggs on the underside of her abdomen. Hatching occurs the following summer, and the resultant larvae assume a pelagic existence. The planktonic larvae undergo four moults before leaving the upper water column and adopting a benthic habitat. Development to the adult stage occurs on the ocean bottom (DFO 2006b). The American lobster is an opportunistic feeder and is known to consume a variety of food including crustaceans, echinoderms, molluscs, fish and polychaetes (DFO 2006b).

Sea Scallop

Sea scallops are generally distributed throughout the shallow (<20 m) coastal region, occurring primarily on sand/gravel or gravel/pebble substrates. This bivalve has been identified as a key organism in the 'scallop bed habitat type' characterized by Catto et al. (1999) as one classification of marine coastal habitat for Newfoundland and Labrador. They are most abundant in shallow sheltered sandy locations, such as western Placentia Bay. Commercial and recreational harvesting of sea scallops occurs in areas around Newfoundland, including Fortune Bay, Placentia Bay, and St. Mary's Bay.

Spawning typically occurs in September and October. Both the eggs and larvae are planktonic, the latter for about four weeks. The larva develops a 'foot', which allows it to attach to an appropriate substrate and, once attached, it develops into the juvenile stage. After the juveniles attain a certain size, their byssal attachments are lost and they lie freely on the ocean bottom for development to the adult stage (Black et al. 1993). Larval sea scallops feed on phytoplankton, while the larger juveniles and adults typically feed on plankton and detritus (Black et al. 1993).

Iceland Scallop

An exploratory scallop survey conducted by DFO in 1990 identified an Iceland scallop bed in the Perch Rock area located 15 to 20 km off St. Brides, southeastern Placentia Bay (Dooley 1991). Depth of scallop catches ranged from 55 to 110 m. The best catches at the Perch Rock area in a subsequent DFO investigation occurred at a depth range of 77 to 90 m (Naidu and Seward 1992).

Atlantic Cod

Atlantic cod has historically been one of the leading food fishes in the world, and until recent years was Newfoundland and Labrador's single most important commercial species. The various Atlantic cod populations have decreased precipitously during the past couple of decades, to the point where inshore Atlantic cod appear to be more abundant than those in the offshore areas (DFO 2006c).

Inshore cod spawning occurs in several bays in Newfoundland, including Placentia Bay. During 1997-1998, three cod spawning grounds were identified at Bar Haven, Perch Rock near Cape St. Mary's, and Oderin Bank in Placentia Bay (Lawson and Rose 2000a). Spawning occurs during the March-August period.

Juvenile cod remain pelagic during early growth and then become associated with the seabed. First-year demersal juvenile cod have been found in shallow nearshore waters (<8 m depth) during autumn. First-year juvenile cod have been caught over a variety of substrate types in nearshore waters, including mud, sand, gravel, and cobble. It appears that the preferred inshore habitat for juvenile cod is characterized by dense beds of eelgrass in sheltered coves, although high numbers also occur in areas without eelgrass, both sheltered and exposed. Juvenile cod in inshore waters move from shallow to deep water as they mature to age 3, but do not appear to mix with adult cod until they reach about age 3 to 4 (DFO 2006c).

Atlantic cod larvae and pelagic juveniles feed mainly on zooplankton. Early demersal stage juveniles in inshore areas continue to feed on zooplankton but then switch to benthic and epibenthic invertebrates (Scott and Scott 1988).

There is evidence that capelin are necessary for the optimal growth, condition, and reproductive potential of northern cod (Rose and O'Driscoll 2002). Between 1996 and 2001, cod were sampled in three areas off Newfoundland and Labrador, including Placentia Bay. During January and June sampling, capelin were found in 9.5% of the cod taken in Placentia Bay and constituted 22% of the diet in terms of weight. During both January and June sampling, stomach content weights were highest in Placentia Bay cod compared to cod from Trinity Bay and Hawke Channel. The condition of Placentia Bay cod was usually higher than the condition of cod sampled further north at Hawke Channel, possibly because potential contact between cod and capelin was higher in the southern areas.

All four indices of the 3Ps cod population are below their long-term averages. The two offshore indices (trawl) have been declining, whereas the two inshore indices (fixed gear) have been somewhat stable in recent years (Brattey et al. 2005; Maddock Parsons and Stead 2005; DFO 2006c).

Juvenile Fish

From September to December, 1997-1999, age 0 cod were surveyed at numerous shallow shoreline sites throughout Placentia Bay (Robichaud and Rose 2006). Sites included a variety of habitat types, although most of them had eelgrass. Generally, catches of age 0 cod were higher at sites in the northern part. Highest overall catches were made at Great Brule and Bar Haven North in the inner bay. This study also indicated a density-dependent range expansion for age 0 juvenile cod-that is, as cod abundance increased, the number of occupied sites also increased. These juvenile cod were most likely found at sites with eelgrass, but with increasing abundance came increased occurrence at sites without eelgrass. Sites such as Great Brule and Bar Haven North may represent critical habitat since these two sites consistently had the highest abundances of these fish regardless of overall annual abundance.

Habitat preferences and use of cover of one to four year-old juvenile cod in the inshore waters were investigated with the use of deep sea submersibles (Gregory and Anderson 1997) in areas ranging from 18 to 150 m. Age 2 to 4 juvenile cod were most often associated with areas of coarse substrate and high bathymetric relief (i.e., submarine cliffs). Age 1 juveniles were most often associated with areas of gravel substrate and low relief. Juvenile cod did not exhibit selection for substrates with macroalgae cover.

Placentia Sound has also been identified as a nursery ground for winter flounder (Khan 2003). Sediment of this inshore habitat was described as muddy (Khan 2003).

Adult Fish

The cod stock in Placentia Bay exhibits marked variations in abundance and composition over the course of an annual cycle. The variations seem to be related to movement and mixing of fish from different populations. After spawning season in the spring, resident fish tend to move southward along the eastern side of Placentia Bay and at times move out of the bay and along the Avalon shore. These resident fish are often the larger fish. The smaller fish may stay within Placentia Bay all year long. The larger fish return to Placentia Bay in the fall and overwinter in dense aggregations in the head and western side of the inner bay. There is evidence that cod from other areas visit the bay during the late spring to early fall period. These visitors include fish from St. Pierre Bank, Fortune Bay, and even the Grand Banks. Cod abundance in Placentia Bay increases significantly during the summer months and distribution is more widespread than during the late fall to spring period, especially along the eastern side (Mello and Rose 2005b).

Acoustic surveys in the bay in 1997 and 1998 identified three primary cod spawning grounds: Bar Haven, Oderin Bank, and Perch Rock (Lawson and Rose 2000a). Ground use and spawning times differed between years. Mean spawning female densities were highest at Perch Rock in 1997 and at Oderin Bank in 1998. Peak spawning in 1997 occurred in April but not until June/July in 1998. In both years, cod spawned at sub- or near-zero temperatures.

Robichaud and Rose (2001) provided the first direct evidence through a telemetry study that cod undertaking long-distance feeding migrations may home to a specific spawning ground in consecutive years. Approximately 67% of the fish tagged at the Bar Haven spawning ground in April 1998 were relocated during the two years following spawning. All cod relocated during the 1999 and 2000 spawning seasons were within 10 km of the tagging location at Bar Haven. Several of the fish relocated outside of spawning season in 1999 and 2000 were as far as 110 km from the tagging location. Multiyear homing (1999 and 2000) was observed in 26% of the cod tagged at Bar Haven. Windle and Rose (2005) suggested that spatial familiarity may be a key factor in cod homing, reinforced through multiyear migrations. Relocation rates on the spawning ground were higher for male fish in all years, suggesting that female cod move in and out of male-dominated spawning aggregations (Robichaud and Rose 2003).

Different spawning aggregation structures have also been observed with the application of active acoustics (Rose 1993). The pelagic behaviour of an aggregation of cod was observed in deep water areas (>300 m) and spawning columns were observed in shallow water areas (~50 m). Some of these spawning columns extended as high as 20 m off the ocean floor.

Acoustic surveys and mark-recapture experiments conducted in the late 1990s investigated the seasonal movements and distribution of coastal cod in Placentia Bay (Lawson and Rose 1998, 2000b). Spawning cod tagged in the inner part of the bay in spring moved outwards along both the east and west sides of Placentia Bay during spring and summer, further on the east side, sometimes leaving Placentia Bay entirely. Lawson and Rose (2000b) estimated that 10-30% of the Placentia Bay cod may move in spring and summer into the adjacent stock area, 3L. The majority of tagged cod recaptured in spring the next year following tagging were taken in the bay, perhaps suggesting a return migration. Smaller cod (<50 cm) tended to remain resident in the inner bay and did not migrate as far as larger fish. The degree of aggregation was highest in spring and fall, and lowest in the summer. Cod moved to shallower water after spawning and occupied an increasingly narrow range of depths from spring to fall. Results presented by Lawson and Rose (2000b) were evidence of repeat spawning, year-round residence, and return migrations, suggesting the existence of a Placentia Bay coastal cod stock.

A mark-recapture study of Atlantic cod in NAFO Subdivision 3Ps was initiated in 1997 (Brattey and Healey 2006). Between 1997 and 2006, more than 66,000 cod were tagged at locations in inner and outer Placentia Bay, but primarily the former. The study has indicated a strong inshore residency although these fish seem to disperse mainly in an eastward direction along the inshore during summer. Some of the cod tagged have been caught in other inshore areas within 3Ps, inshore areas outside of 3Ps (Cape St. Mary's to White Bay), and offshore areas within 3Ps. Inshore cod of Placentia Bay are supplemented during late spring, summer and fall by seasonal migrants from various offshore areas (e.g., Burgeo Bank, St. Pierre Bank, Halibut Channel).

Atlantic Herring

There are five coastal herring stocks in east and southeast Newfoundland, one of which is the St. Mary's Bay-Placentia Bay (SMB-PB) stock (Wheeler et al. 2004; DFO 2006d). Although there are fall spawning herring, spring spawners appear to dominate most stocks. Atlantic herring generally spawn during May and June. These demersal spawners deposit adhesive eggs on stable bottom substrates, typically in shallow (<20 m depth) coastal waters, primarily on gravel or rocky bottom where there is an abundance of seaweed. Other documented spawning substrates include sand and bare rock. Eelgrass has been associated with herring spawning in some locations (Scott and Scott 1988; DFO 2006d,e).

The larvae that hatch from the demersal herring eggs are pelagic. The pelagic larvae and the juveniles that develop from them are known to make diel (night-to-day) vertical migrations. The juveiles and adults tend to avoid the surface waters during daylight hours, likely a strategy for avoiding avian predators. These pelagic schooling fish do not appear to have any substrate preference during juvenile and adult phases. Atlantic herring are visual feeders, consuming primarily plankton during daylight hours (Scott and Scott 1988).

Spring-spawned herring accounted for 70% of the commercial fishery landings in SMB-PB in 2005, up 7% from 2004. Commercial landings in this area in 2005 were up 2-3 % from 2004 (DFO 2006d).

In the research gill net program, catch rates in SMB-PB were stable from 2004 to 2006 but remained below the historical mean. Gill net fishers indicated that herring abundance was higher in 2006 than in 2004 but still below average. Purse seine fishers indicated that herring abundance was similar in 2006 to 2004 and above average. A joint industry/DFO acoustic survey in Placentia Bay and St. Mary's Bay in February 2005 indicated substantial stock decline since the 2000 survey, and that spawning intensity was also lower in 2004 than in 2002 (DFO 2006e).

Mean weight (ages 4 to 10) has a decreased since the early 1980s. The mean weight in 2003 was 89% of the long-term mean weight. This could potentially lead to an increase in fishing mortality per tonne of fish caught. Overall, the status of the SMB-PB herring stock has deteriorated since 2002 (DFO 2006d,e; Wheeler et al. 2004).

Sjare et al. (2003) identified areas of herring aggregation in all five regional subdivisions of shoreline biological communities based on local ecological knowledge (Catto et al.1999). The primary areas indicated include coastal waters between Lamaline and St. Lawrence on the southern part of the Burin Peninsula, around Boat Harbour/Brookside/Little Harbour West on the west side of Placentia Bay, at the head of Placentia Bay, and around the islands of inner Placentia Bay (Merasheen Island/Long Island).

Lumpfish

Lumpfish are semi-pelagic, spending much of their time far from the coast. Adult lumpfish exhibit seasonal migrations in Newfoundland waters, moving into shallow coastal waters to spawn in spring and early summer, and then returning to deeper offshore waters in late summer and early fall. Mature female lumpfish are commercially fished for their roe during the inshore spring-summer spawning season (DFO 2002a).

Lumpfish eggs adhere to the nest substrate, which is most often rock. Larval hatch typically occurs during May-June and the larvae attach to macroalgae and hard substrate by means of an adhesive disc. They swim freely and feed four to seven days after hatching, but may also feed from the attached position. Juvenile lumpfish appear to remain in the coastal area up to age 1. They then adopt the semipelagic lifestyle characteristic of adult lumpfish and distribute themselves offshore (Scott and Scott 1988; DFO 2002a).

Free-swimming larvae and first-year juveniles feed on zooplankton. After adopting the semipelagic lifestyle, lumpfish switch to a variety of benthic and pelagic food items including ctenophores, amphipods, polychaetes, molluscs, fish and ichthyoplankton (Scott and Scott 1988).

Capelin

These pelagic fish exhibit inshore-offshore migrations associated with spawning. Capelin typically overwinter in offshore waters, move shoreward in early spring to spawn on appropriate beaches in spring/summer, and return to offshore waters in autumn. Exact timing of spawning appears to be highly dependent on water temperature. Juvenile capelin are found in Newfoundland bays but capelin larvae appear to be rapidly carried out of the bays and inshore areas by surface currents (DFO 2001).

Five stock complexes of capelin have been recognized in the Newfoundland region based on spawning and overwintering locations, including the St. Pierre Bank stock that spawns on the south coast of Newfoundland (Carscadden et al. 1989).

Beach suitability for spawning is primarily dependent on substrate type, with capelin showing a preference for gravel. Suitable beaches are found in exposed, moderately exposed and sheltered locations. Beach spawning by capelin is demersal with the eggs typically being deposited in the intertidal zone, although capelin are also known to deposit eggs in the subtidal zone in depths ranging up to 37 m (Carscadden et al. 1989).

Capelin larvae remain on the gravel, upon hatching, until they are flushed by wave action. Once flushed from the spawning sediments, the capelin larvae are pelagic and rapidly advected from embayments into open bays and eventually into the offshore. Pelagic juvenile capelin generally do not exhibit substrate preferences, although when they occur in shallow nearshore waters, they are often associated with eelgrass habitat in mud, sand and/or gravel substract. Adult capelin also do not tend to exhibit any preferences for substrate. The adults do exhibit diel (night-to-day) vertical migrations in that they occupy the lower water column during the day and move upwards at night. During autumn, the diel vertical migration shows a reverse pattern (Scott and Scott 1988; Carscadden et al. 1989). Capelin feed on various plankton, including copepods and amphipods, mainly during non-spawning times. (Scott and Scott 1988).

The abundance and distribution of capelin in Placentia Bay were assessed using acoustic surveys in January, March, and June 1998, and in January 1999 (O'Driscoll and Rose 1999). Capelin biomass was highest in June 1998, estimated at 132,000 t in the outer bay. Estimated biomasses were much lower during the other three surveys, ranging from 390 t in January 1999 to 13,000 t in January 1998. In addition to these seasonal differences in spatial distribution, seasonal differences in vertical distribution were also observed. Capelin occurred near the surface at night and near the bottom during the day in June 1998. No diurnal vertical migration was evident during the other three survey times. Capelin tended to remain near the bottom during January and March. Most of the capelin observed during the four surveys were immature, approximately 75% measuring less than 130 mm.

The highest capelin densities observed during January 1998 occurred on the eastern side of outer Placentia Bay, and immediately to the south of Merasheen Island and Red Island (O'Driscoll and Rose 1999). In March 1998 the highest densities had shifted towards the western side of outer Placentia Bay and throughout more of the inner bay. June 1998 densities were distributed relatively evenly throughout outer Placentia Bay. The survey in January 1999 found the highest densities in Paradise Sound and towards the head of the bay.

Sjare et al. (2003) identified areas with capelin spawning beaches and offshore spawning areas based on local ecological knowledge. Capelin spawning beaches occur in all five of the regional subdivisions of shoreline biological communities described by Catto et al. (1999). Areas with offshore capelin spawning were identified in four of the five regional subdivisions; the exception was the Swift Current Estuarine Region. The most extensive area of offshore spawning activity was identified off the south coast of the Burin Peninsula.

Atlantic Mackerel

This pelagic fish undertakes long annual migrations, often travelling in dense schools in spring and fall. Most mackerel spawning occurs in the southern Gulf of St. Lawrence in June and July. Recent changes in mackerel migration routes are responsible for a marked increase of landings on the east coast of Newfoundland in 2004 and 2005, and an accompanying drop in catches in the southern Gulf of St. Lawrence. Recent unusual oceanographic conditions in the southern Gulf of St. Lawrence could be the reason for this change in migration. Spring migration of mackerel may be delayed or occur elsewhere in order to avoid cold water in the Gulf of St. Lawrence (DFO 2006f).

American Plaice

American plaice occur both inshore and offshore in the Newfoundland region, typically in depths of 90 to 2500 m (Pitt 1989). The fishery for this species was once the largest flatfish fishery in the Newfoundland region; declining stocks resulted in a fishing moratorium in 1993 (DFO 2005a; Morgan et al. 2005).

Spawning typically occurs between March and September, with peak activity in April and May. The northeastern and eastern slopes of the Grand Bank are probably the most important offshore spawning areas in eastern Newfoundland waters. American plaice also spawn in inshore waters. Eggs and larvae of this flatfish are pelagic, with larval hatch typically occurring within two weeks of spawning. Past surveys in August and September have indicated the presence of pelagic juvenile plaice in inshore waters. Once the pelagic juveniles switch to demersal habitat and develop into adults, the typical depth range is 55 to 130 m, although they occur in much shallower or deeper waters (DFO 2005a; Morgan et al. 2005). Larval and pelagic juvenile plaice feed on small phytoplankton and zooplankton. When they settle to the ocean bottom, the diet switches to larger food items, including echinoderms and sand lance (Scott and Scott 1988).

Winter Flounder

This species occurs in the western North Atlantic Ocean from southern Labrador, to the coast of Georgia, USA. It is a coastal flatfish that inhabits depths ranging from 5 to 100 m, typically less than 40 m. Winter flounder are most often associated with soft or moderately hard bottoms. This flounder is primarily a daytime feeder, preying on benthic organisms including algae, polychaetes, crabs, amphipods, shrimps, sea urchins, molluscs and fish eggs (Scott and Scott 1988; DFO 2005b; Fish Base 2007).

The winter flounder typically spawns in late winter/spring in Newfoundland waters. The female releases eggs that settle to the bottom and adhere to rocks and vegetation. Hatching occurs 2-3 weeks after fertilization and the larvae drift in surface waters for 2 to 3 months before the onset of metamorphosis and settlement to the bottom (Scott and Scott 1988; DFO 2005b).
The winter flounder is fished commercially in some areas of eastern Canada (e.g., NAFO Division 4T in the Gulf of St. Lawrence) for bait and limited food markets (DFO 2005b).

2.4.4 Bioindicators

Cultured blue mussels have been employed by VBNC (LGL) as bioindicators since October 2005, at six locations within Long Harbour. A reference station using blue mussels was set up in May 2006. Stations within Long Harbour provide coverage from the head of the harbour (Sandy Point) to the mouth of the harbour (Shag Rocks). Water depths of the deployed mussels range from 6 to 17 m (LGL 2007).

The general trend associated with soft tissue chemical loading is for higher concentrations in mussels exposed to the environment in the inner part of Long Harbour than those in the outer harbour. Growth rate and condition index have been highest in the outer Long Harbour mussels. Analyses have been conducted for varying lengths of time (LGL 2007).

As part of the VBNC baseline program, winter flounder were collected at a location between Shag Rocks and Crawley Island in September 2006, and at the reference station located south of the harbour mouth. Winter flounder were used because of their direct contact with the surficial sediment in the benthic habitat. Chemical analyses were conducted on skeletal muscle, liver tissue and kidney tissue, and generally, chemical concentrations were higher in tissues of fish collected within Long Harbour than in those collected at the reference station (LGL 2007).

2.4.5 Fish Species at Risk

The provincial legislation that concerns Species at Risk is the *Endangered Species Act*. Their listing as of 6 October 2006 included no marine fish species. The relevant federal *Species at Risk Act* (*SARA*) Schedule 1 listing includes Wolfishes - *Anarhichas denticulatus, Anarhichas minor and Anarhichas lupus.*

Wolffish

While the three Wolffish species may occasionally occur in or near the Project Area, they are usually distributed in much deeper water. Northern wolffish and spotted wolffish are listed as *threatened* in Schedule 1 of *SARA*, and the Atlantic wolffish is listed as a species of *special concern*. Of the three species, northern wolffish is the deepest residing species and Atlantic wolffish is the shallowest. Based on DFO trawl surveys in Newfoundland and Labrador waters between 1971 and 2003 (Kulka et al. 2004), northern wolffish were most concentrated during December to May in areas where depths ranged from 500 to 1000 m, shifting to slightly shallower areas from June to November. Spotted wolffish concentrations were highest in areas with water depths ranging from 200 to 750 m at all times of the year, peaking in 300 m areas from June to November. They were most concentrated in areas with depths approximating 250 m at all times of the year.

Tagging studies have shown that northern wolffish do not migrate long distances and do not form large schools. It is a benthic and bathypelagic predator, preying upon jellyfish, comb jellies, crabs, brittle stars, seastars and sea urchins. Its predators include redfish and Atlantic cod (Scott and Scott 1988).

Tagging studies have shown that spotted wolffish only migrate locally, and do not form schools (DFO 2002b). Spatial analysis of DFO research vessel catch data indicate that abundance declined from the late 1980s to the mid-1990s, with an increase in abundance during two survey seasons since the mid-1990s (Kulka et al. 2003). Its prey includes hard-shelled invertebrates such as crustaceans and molluscs, echinoderms and fish (primarily those discarded by trawlers). The species has few predators, although remains have been found in the stomachs of Atlantic cod, pollock and Greenland shark (Scott and Scott 1988).

There is no evidence that Atlantic wolffish migrate long distances or form schools in Newfoundland waters (DFO 2002b). In the northwest Atlantic, they feed primarily on benthic invertebrates such as echinoderms, molluscs and crustaceans, as well as small amounts of fish. No predators of adult Atlantic wolffish have been identified, but juveniles have been found in the stomachs of Atlantic cod (Scott and Scott 1988).

It is not known with certainty if any of these three wolffish species spawn in the Placentia Bay area, although it is probable given the limited migration of the species. During late fall fertilized eggs are deposited on either a hard bottom or underwater ledge (Scott and Scott 1988), producing larvae that are large (2-cm long upon hatching) and semi-pelagic (DFO 2002b).

Both northern and spotted wolffish are incidentally captured in fisheries directed at other commercial species. Incidental capture in the commercial fishery is considered the dominant source of human-induced mortality. Permits, education on live release, and gear modification have been identified as the key issues in ensuring the survival of these fish (DFO 2004).

COSEWIC Listings

It is considered advisable to address the COSEWIC listing as some of these species may attain (or change) the federal and/or provincial legal listings during the life of the Project. An analysis of the COSEWIC listings (August 2006) concluded that relevant changes to *SARA* could include potential inclusion of porbeagle shark (*Lamma nasus*) as endangered, shortfin mako shark (*Isurus oxyrinchus*) as threatened, and American eel (*Anguilla rostrata*) as a special concern.

For legal purposes, the *SARA* establishes Schedule 1 endangered and threatened species as the official list of wildlife species at risk. Species that were designated at risk by COSEWIC prior to October 1999 must be reassessed using revised criteria before they can be considered for addition to Schedule 1 of *SARA*.

Porbeagle Shark

The porbeagle shark was designated as endangered by COSEWIC in May 2004 (COSEWIC 2004). This large cold-temperate coastal and oceanic shark is distributed across the North Atlantic and is known to occur in southern Newfoundland waters during spring and summer (Scott and Scott 1988). The porbeagle shark is typically most common on continental shelves but is also found far from land in ocean basins and occasionally close to shore. It mates within NAFO Subdivision 3Ps during late summer/fall, followed by the release of live young (pups) the following winter (Campana et al. 2001). The pupping occurs outside of Placentia Bay.

Porbeagle sharks are predators of various fish species and cephalopods (Campana et al. 2001). Pelagic species are the primary prey during the spring and summer, followed by a shift to groundfish species in the winter. This prey shift reflects the seasonal change of distribution of porbeagle (i.e., migration to deeper areas in fall and winter) (Campana et al. 2001).

Between March and July 2005, three DFO meetings were held to assess the recovery potential of NAFO Subarea 3-6 porbeagle shark (O'Boyle 2005). DFO (2005c) indicates that porbeagle in the northwest Atlantic can recover if human-induced mortality is sufficiently low. The only sources of human-induced mortality identified in DFO (2005d) are fisheries that capture this shark as bycatch.

Shortfin Mako Shark

The shortfin mako shark was designated as *threatened* by COSEWIC in April 2006. Shortfin makos are distributed circumglobally in all tropical and temperate seas. In Canadian Atlantic waters, it is typically associated with warm water in and near the Gulf Stream. There are no reliable population-level stock assessments available in the northwest Atlantic. Trend information based on declines in bycatch rates in the entire northwest Atlantic suggests that shortfin mako populations may have decreased in the past 15 to 30 years (COSEWIC 2006a).

This is a highly migratory seasonal visitor (late summer and fall) to Canada's Atlantic coast, typically occurring anywhere from surface waters to depths of about 500 m. The life cycle of the shortfin mako is not completely understood. It is ovoviviparous (internal hatching) and likely breeds outside of Canadian waters. Few mature makos have been caught in Canadian waters (COSEWIC 2006a).

American Eel

The status of American eel is discussed in the freshwater Section 2.3.6.

2.4.6 Marine-related Avifauna

Marine-related birds are considered here to include raptors, shorebirds and waterfowl that feed in the tidal zone, as well as birds that live on the ocean. Species known to occur in Placentia Bay are listed in Table 2.12.

Placentia Bay is one of the richest bays in Newfoundland for seabirds. Four seabird colonies are designated as Important Bird Areas (Figure 2.27; Table 2.13). This includes Cape St. Mary's, which supports the largest of three northern gannet colonies in Newfoundland and nearly 20% of the Atlantic Canada breeding population. Middle Lawn Island, Burin Peninsula supports the only known sustainable breeding colony of manx shearwaters in North America. Large numbers of greater and sooty shearwaters that breed in the Southern Hemisphere during winter spend part of the summer in Placentia Bay feeding on capelin and other fish while moulting flight feathers. Concentrations of summering shearwaters in eastern Placentia serve as the basis for a 1675 km^2 area on the east side of Placentia Bay being designated an Important Bird Area (IBA) (www.ibacanada.com). In the winter large aggregations of sea ducks, such as common eiders, the most northerly wintering distribution of black scoters, and the eastern harlequin duck are found in parts of Placentia Bay. The eastern population of harlequin duck is listed as a species of s*pecial concern* by COSEWIC and *vulnerable* under the *ESA* of Newfoundland and Labrador. There are over 365 islands in Placentia Bay, many of which support small colonies of terns, gulls and black guillemots.

Table 2.12 Seasonal Occurrence of Sea-associated Birds in Placentia Bay

Abundance	Species	Scientific Name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Common	Canada Goose	*Branta canadensis*												
Rare	Gadwall	*Anas strepera*												
Scarce	American Wigeon	*Anas americana*												
Common	American Black Duck	*Anas rubripes*												
Scarce	Mallard	*Anas platyrhynchos*												
Scarce	Blue-winged Teal	*Anas discors*												
Uncommon	Northern Pintail	*Anas acuta*												
Common	Green-winged Teal	*Anas crecca*												
Uncommon	Ring-necked Duck	*Aythya collaris*												
Uncommon	Greater Scaup	*Aythya marila*												
Scarce	Lesser Scaup	*Aythya affinis*												
Scarce	King Eider	*Somateria spectabilis*												
Common	Common Eider	*Somateria mollissima*												
Scarce	Harlequin Duck	*Histrionicus histrionicus*												
Uncommon	Surf Scoter	*Melanitta perspicillata*												
Uncommon	White-winged Scoter	*Melanitta fusca*												
Uncommon	Black Scoter	*Melanitta nigra*												
Common	Long-tailed Duck	*Clangula hyemalis*												
Scarce	Bufflehead	*Bucephala albeola*												
Uncommon	Common Goldeneye	*Bucephala clangula*												
Rare	Barrow's Goldeneye	*Bucephala islandica*												
Rare	Hooded Merganser	*Lophodytes cucullatus*												
Uncommon	Common Merganser	*Mergus merganser*												
Common	Red-breasted Merganser	*Mergus serrator*												
Uncommon	Red-throated Loon	*Gavia stellata*												
Common	Common Loon	*Gavia immer*												
Scarce	Horned Grebe	*Podiceps auritus*												
Uncommon	Red-necked Grebe	*Podiceps grisegena*												
Common	Northern Fulmar	*Fulmarus glacialis*												
Common	Greater Shearwater	*Puffinus gravis*												
Common	Sooty Shearwater	*Puffinus griseus*												
Uncommon	Manx Shearwater	*Puffinus puffinus*												

Abundance	Species	Scientific Name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Scarce	Wilson's Storm-Petrel	*Oceanites oceanicus*												
Common	Leach's Storm-Petrel	*Oceanodroma leucorhoa*												
Common	Northern Gannet	*Morus bassanus*												
Common	Double-crested Cormorant	*Phalacrocorax auritus*												
Common	Great Cormorant	*Phalacrocorax carbo*												
Uncommon	American Bittern	*Botaurus lentiginosus*												
Rare	Great Blue Heron	*Ardea herodias*												
Common	Osprey	*Pandion haliaetus*												
Common	Bald Eagle	*Haliaeetus leucocephalus*												
Uncommon	Black-bellied Plover	*Pluvialis squatarola*												
Uncommon	American Golden-Plover	*Pluvialis dominica*												
Common	Semipalmated Plover	*Charadrius semipalmatus*												
Common	Spotted Sandpiper	*Actitis macularius*												
Scarce	Solitary Sandpiper	*Tringa solitaria*												
Common	Greater Yellowlegs	*Tringa melanoleuca*												
Scarce	Lesser Yellowlegs	*Tringa flavipes*												
Common	Whimbrel	*Numenius phaeopus*												
Scarce	Hudsonian Godwit	*Limosa haemastica*												
Common	Ruddy Turnstone	*Arenaria interpres*												
Scarce	Red Knot	*Calidris canutus*												
Uncommon	Sanderling	*Calidris alba*												
Common	Semipalmated Sandpiper	*Calidris pusilla*												
Common	Least Sandpiper	*Calidris minutilla*												
Common	White-rumped Sandpiper	*Calidris fuscicollis*												
Rare	Baird's Sandpiper	*Calidris bairdii*												
Uncommon	Pectoral Sandpiper	*Calidris melanotos*												
Common	Purple Sandpiper	*Calidris maritima*												
Uncommon	Dunlin	*Calidris alpina*												
Uncommon	Short-billed Dowitcher	*Limnodromus griseus*												
Common	Wilson's Snipe	*Gallinago delicata*												
Common	Red-necked Phalarope	*Phalaropus lobatus*												
Common	Red Phalarope	*Phalaropus fulicarius*												
Common	Black-headed Gull	*Larus ridibundus*												
Scarce	Bonaparte's Gull	*Larus philadelphia*												

Abundance	Species	Scientific Name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rare	Mew Gull	*Larus canus*	■	■	■	■							■	■
Common	Ring-billed Gull	*Larus delawarensis*				■	■	■	■	■	■	■		
Common	Herring Gull	*Larus argentatus*	■	■	■	■	■	■	■	■	■	■	■	■
Common	Iceland Gull	*Larus glaucoides*	■	■	■	■	■					■	■	■
Scarce	Lesser Black-backed Gull	*Larus fuscus*	■	■	■	■					■	■	■	■
Uncommon	Glaucous Gull	*Larus hyperboreus*	■	■	■	■						■	■	■
Common	Great Black-backed Gull	*Larus marinus*	■	■	■	■	■	■	■	■	■	■	■	■
Rare	Sabine's Gull	*Xema sabini*							■	■	■			
Common	Black-legged Kittiwake	*Rissa tridactyla*	■	■	■	■	■	■	■	■	■	■	■	■
Rare	Caspian Tern	*Hydroprogne caspia*				■	■			■	■			
Common	Common Tern	*Sterna hirundo*					■	■	■	■	■			
Common	Arctic Tern	*Sterna paradisaea*					■	■	■	■	■			
Scarce	Great Skua	*Stercorarius skua*					■	■	■	■	■	■		
Scarce	South Polar Skua	*Stercorarius maccormicki*					■	■	■	■	■	■		
Uncommon	Pomarine Jaeger	*Stercorarius pomarinus*					■	■	■	■	■	■		
Uncommon	Parasitic Jaeger	*Stercorarius parasiticus*					■	■	■	■	■	■		
Scarce	Long-tailed Jaeger	*Stercorarius longicaudus*					■	■	■	■	■			
Common	Dovekie	*Alle alle*	■	■	■	■						■	■	■
Common	Common Murre	*Uria aalge*	■	■	■	■	■	■	■	■	■	■	■	■
Common	Thick-billed Murre	*Uria lomvia*	■	■	■	■	■	■	■	■	■	■	■	■
Common	Razorbill	*Alca torda*	■	■	■	■	■	■	■	■	■	■	■	■
Common	Black Guillemot	*Cepphus grylle*	■	■	■	■	■	■	■	■	■	■	■	■
Common	Atlantic Puffin	*Fratercula arctica*	■	■	■	■	■	■	■	■	■	■	■	■
Uncommon	Belted Kingfisher	*Ceryle alcyon*	■	■	■	■	■	■	■	■	■	■	■	■
Common	American Crow	*Corvus brachyrhynchos*	■	■	■	■	■	■	■	■	■	■	■	■
Common	Common Raven	*Corvus corax*	■	■	■	■	■	■	■	■	■	■	■	■

Note: The shaded areas indicate months of occurrence in Placentia Bay.