5.0 EXISTING ENVIRONMENT

5.1 Geology

The bedrock of Nova Scotia contains an abundance of salt formations. Salt is mined by underground methods and by solution mining methods. The thickness, depth of burial and amount of structural deformation of salt formations varies considerably throughout the province.

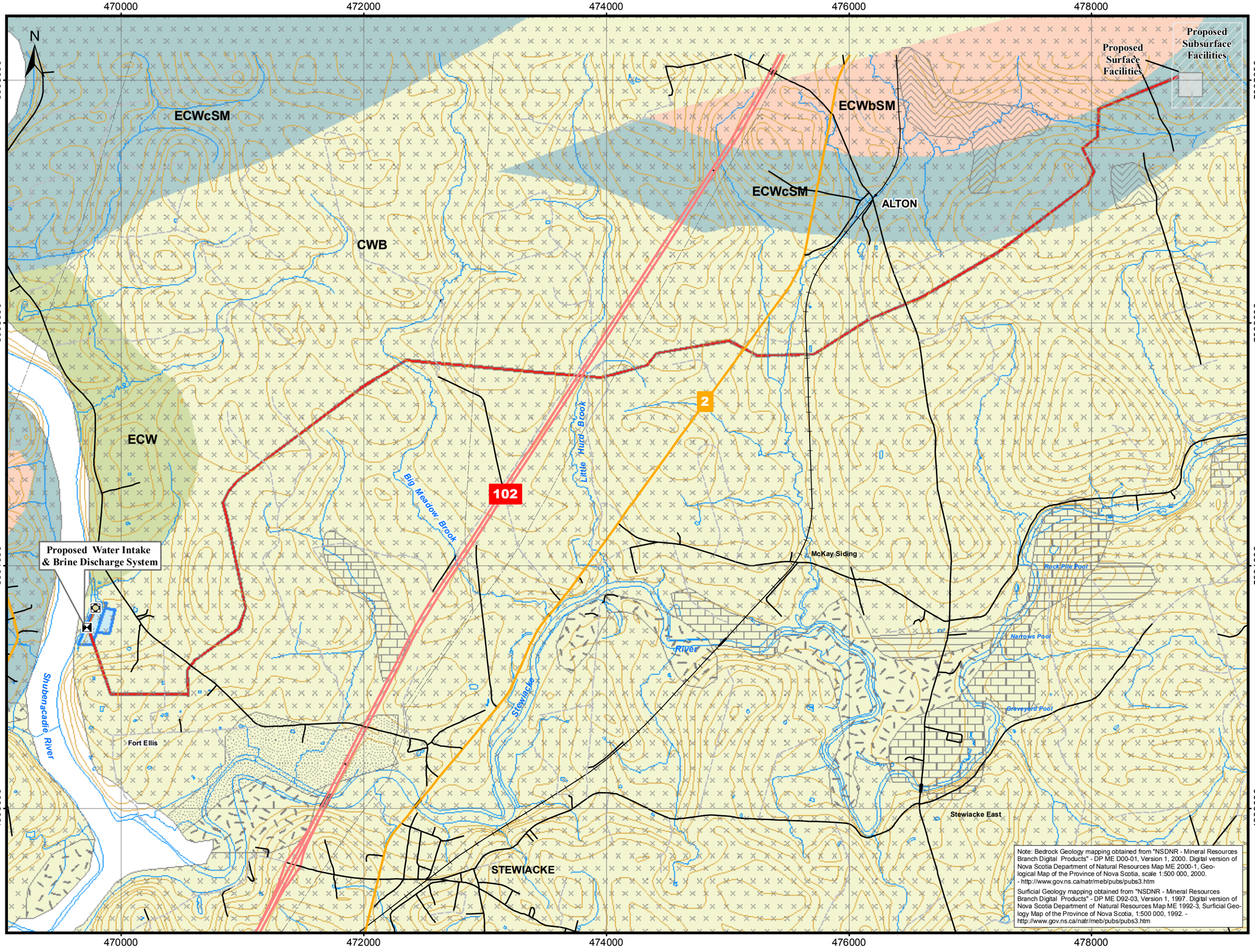
Salt formations which are suitable for gas storage in caverns must meet several criteria. The formations must be thick enough to easily accommodate the space required for storage caverns within the upper and lower boundaries of the salt. Also, the salt must be buried at a sufficient depth to withstand high pressure natural gas; the deeper the depth of burial, the higher the maximum allowable pressure, which improves the economics of a gas storage project. Finally, the structural deformation of the salt, which takes place over geological time, cannot be too severe, otherwise caverns will not form in an anticipated shape, in accordance with the geotechnical design, which maximizes strength and stability of the cavern. Many of the salt formations in Nova Scotia, such as in Pugwash, Nepan and Cape Breton, are highly deformed and folded and are not suitable for natural gas storage.

The Alton Project area is underlain by the Shubenacadie – Stewiacke basin, which contains a large, flat-lying bedded salt formation referred to as the Stewiacke formation, which is part of the Windsor Group. This basin has been described by R.C. Boehner (1986) as: “The deposit’s thickness, its relatively undisturbed nature, its great lateral extent and reasonable depth, and the virtual absence of salt springs, all favor use for the future development of mines and underground storage facilities.” This description indicates potential for underground storage of gas in the Shubenacadie – Stewiacke basin. In addition to being underlain by bedrock of the Windsor Group, the Nova Scotia bedrock geologic mapping also indicates that Project components (pipeline, holding pond and mixing pond) are underlain by bedrock of the Mabou Group, also composed of sedimentary units (Keppie 2000) (Figure 5.1).

In early 2005, 8 km of seismic data was acquired from Hunt Oil Company. This survey tied into the EOG/Hunt Cloverdale #1 well and the Hunt Alton 99-1 well, which had encountered 420 m of salt. This program allowed Alton to regionally understand the salt formation in the area surrounding the permits held today. In 2005, a gravity survey was conducted in order to correlate the seismic data with gravity in an attempt to gain a better understanding of the formation and to outline potentially deeper and thicker portions of the salt formation. Later that year, Alton conducted a 28 km seismic survey within the present salt and potash licences and mineral exploration licences. The survey defined an area with the desired geological characteristics to allow for the storage of hydrocarbons. In the winter and spring of 2006, Alton drilled a core hole 650 m to the north of the Hunt Alton 99-1 well to confirm the seismic interpretation and candidacy of the salt formation for the use of underground hydrocarbon storage. The drilling program was conducted on the Special Licence No.1-05. The Alton Project drilled a 946 m deep core hole, named ALT 06-01, through the salt formation. The core hole intersected the top of the salt at 470 m depth, with the bottom of the salt at 946 m depth. Geological and geochemical analysis as well as geotechnical testing of the drill core confirms the suitability of the salt formation for natural gas storage. Only the bottom of the salt formation, from approximately 858 m to 946 m depth, will be used for cavern development. This allows for higher pressures than a shallower cavern, and provides additional upper rock to ensure a proper seal to the surface. As a result of the drilling and seismic programs, Alton was able to confirm the salt formation’s suitability for the storage of hydrocarbons.

5.2 Water Resources

A desktop evaluation to determine the presence of potential water wells within approximately 500 m of the proposed water pipelines was completed using the most recent aerial photography (*i.e.,* 2004) and the most recent topographic mapping (*i.e.,* 1997). During the assessment, water supplies were assumed to be located on properties with one or more structures present. It was determined that there are approximately 60 water supplies located within 500 m of the pipeline. Of these, most are suspected to be either drilled or dug wells. No ground truthing of the desktop study was completed and therefore the actual number of water wells may be more or less than 60. Interaction between groundwater wells and gas leaking due to failure of a cavern is unlikely because the proposed caverns are much deeper than the maximum depth of potable ground water, and the intervening strata contain 380 m of additional impermeable salt, the physical properties of these salt formations make it unlikely to fracture, and safety systems and standards will minimize potential risks to groundwater users.



alton
NATURAL GAS STORAGE LP

Alton Gas Storage Project

Figure 5.1 Geology of the Project Area

- Water Intake Pipes
- Brine Discharge Pipe
- Bridge
- Major Highway
- Collector Highway
- Paved Road
- Unpaved Road
- Rail
- Contour (5m)
- Watercourse
- Waterbody
- Proposed Pipeline Route (20m Row)
- Holding Ponds
- Proposed Surface Facilities
- Proposed Subsurface Facilities

Surficial Cover

Post Last Glaciation (Holocene)

Organic Deposits
Sphagnum moss, peat, gyttia, clay

Alluvial Deposits
Gravel, sand, mud; bedded coarse at base, finer at top, stream channels generally gravelly sand, flood plains sand

Marine Deposits
Gravel, sand, silt, clay; locally overlain by peat (saltmarsh)

Last Glaciation (Wisconsinian)

Glaciolacustrine Deposits
Sand, silt, clay, laminated to massive, massive or crudely stratified diamictons (mixture of gravel, sand, and mud)

Glaciofluvial Deposits - Kame fields and Esker Systems
Gravel, sand and silt, diamicton layers, poorly to well bedded, horizontal to angular beds, faulting and collapse features common

Ground Morraine and Streamlined Drift - Stony Till Plain
Silty, compact, material derived from both local and dist. sources

Bedrock Geology

Watering Brook Formation, Mabou Group, Carboniferous

CWB — mudstone, shale, gypsum, anhydrite, halite

Undivided Windsor Group, Windsor Group, Early Carboniferous

ECW — res siltstone, mudstone, sandstone, shale, conflomerate, gypsum, anhydrite, halite

Wentworth Station, Miller Creek, and MacDonalds Road Formations (B subzone), Windsor Group, Early Carboniferous

ECWbSM — siltstone, limestone, dolostone

Murphy Road and Green Oaks Formations (C-E subzone), Windsor Group, Early Carboniferous

ECWcSM — sandstone, siltstone, limestone, dolostone, anhydrite, gypsum

Map Parameters
Projection: UTM, NAD83, Zone 20
Date: June 06th, 2007
Scale 1 : 30,000
Project No.: 1012229

0 250 500 1,000
Metres

Jacques Whitford

According to the Nova Scotia Well Log Database of logs for wells constructed between 1940 and 2004, drilled wells in the vicinity of the Project are generally installed in sedimentary bedrock. This is corroborated by Nova Scotia bedrock geologic mapping which indicates that the Project is underlain by bedrock of both the Mabou and Windsor Groups which are both composed of sedimentary units (Keppie 2000). A summary of the pertinent well properties included in these logs is presented in Table 5.1.

TABLE 5.1 Summary of Water Well Records in the Vicinity of the Project

	Well Depth (m)	Casing Length (m)	Estimated Yield (L/min)	Water Level (m)	Overburden Thickness (m)
Minimum	4.6	0.8	9.5	0.5	1.5
Maximum	74.7	60.7	757	33.5	10.7
Average	25.7	20.1	93.2	8.9	6.1
Median	7.2	6.7	22.7	2.9	6.1
Number	22	22	16	14	2

Source: Nova Scotia Environment and Labour (NSEL). 1940-2004. Well Driller Logs.

Groundwater quality from Mabou Group bedrock can be expected to be of good chemical quality with a tendency toward hardness. Iron and manganese concentrations in excess of relative aesthetic guidelines are found in approximately half of all wells located in Mabou Group bedrock (Gibb and McMullin 1980).

Within the Windsor Group bedrock, the most expected concerns are high hardness levels, sulphate, total dissolved solids (TDS) and iron (Chang 1970). Aesthetic drinking water guidelines for sulphate, TDS and iron are 500 mg/L, 500 mg/L and 0.3 mg/L, respectively. Although there is no guideline for hardness, levels between 80 and 100 mg/L are considered acceptable, levels greater than 200 mg/L are considered to be poor but tolerable, and those in excess of 500 mg/L are considered to be unacceptable (Health Canada 2006).

In addition to the above naturally-occurring water quality issues, common problems reported by Nova Scotia well owners include: elevated sodium and chloride from road salt; coliform bacteria from surface sources impacting poorly constructed dug and drilled wells; and low pH and/or associate plumbing corrosion in shallow wells constructed in sand aquifers or fractured crystalline bedrock.

5.3 Estuarine Hydrology

The Shubenacadie River is a tidal bore river that fluctuates widely in salinity, temperature, water elevation, suspended sediment and river bottom configuration over very short temporal periods (less than 1-hour). The river meander length is approximately 50 km from its source at Grand Lake to its mouth at Maitland on Cobequid Bay (Figure 1.1). The river system receives freshwater from a relatively large watershed area (2600 km^2) that includes the Stewiacke River, a tributary to the Shubenacadie River, where the confluence is located approximately 22 km upriver of the mouth. Due to the extreme tidal forcing (>10 m large tidal range) from Cobequid Bay, the lower 30 km of the river is tidal and therefore estuarine in nature. Within this lower reach of the Estuary, brackish water has salinities that can vary from 0 to 25 ppt over a single tidal cycle.

The turbulence associated with the passage of the tidal bore in the Shubenacadie Estuary plays an important role in the transport of sediment within the estuarine system and Cobequid Bay. Suspended sediment is continuously being reworked from bottom sediments and eroded from exposed banks to form the extensive shoals, varying temporally and spatially, within the river and salt marshes throughout Cobequid Bay. Near the Project area, there is a dyke on the east bank of the Estuary to address flooding of adjacent land. There is also rip-rap (rock) along the east bank of the Estuary which was placed there in the 1970s.

In order to assess the trends and variability in physical oceanographic and hydrologic processes that influence the Shubenacadie Estuary, existing data on bathymetry, currents, salinity, and flow discharge, though sparse, was collected. The Canadian Hydrographic Service (CHS) has no bathymetry or tidal data for the Shubenacadie Estuary. Charts would be unreliable to mariners due to the rapid changes in river bottom (formation and erosion of large shoals) from year to year. Flow data along the tidal portion of the river is non-existent, but freshwater gauging stations (Water Survey of Canada) do exist upriver (non-tidal reach) of the Shubenacadie and Stewiacke Rivers. Due to limited available data, Martec Ltd. carried out an oceanographic field program in the summer and fall of 2006 to supplement the missing data and provide the necessary data for engineering design of the outfall, brine dispersion modeling and environmental studies. The 2006 program consisted of measuring tidal flows, water elevation, bathymetry at the proposed outfall, and salinity. Results are detailed in Appendix A.

The 11 m large tide observed at Maitland on Nov 06, 2006 reduced to a tidal range of just over 4 m near the Project area. The difference in tidal range between the two sites is primarily due to the increase of river bottom elevation from Maitland to the Project area. This increase in river bottom elevation is not a gradual one, but highly variable along this 20 km section of river. Typically, the water elevation rises from low to high water in less than two hours and then falls for a period of 10 to 11 hours. It is important to note that during the falling tide, water elevation falls most rapidly for a period of approximately three hours after high tide and then gradually decreases in elevation until the arrival of the next tidal bore.

Measured river flow and water elevation within the vicinity of the Project area show that peak flood flow occurs approximately 30 to 60 minutes before high tide. Measured currents at peak flood flow are in excess of 2.0 m/s for the large tide (1.4 m/s for the small tide) at mid-channel. Once high tide is reached, the water continues to flow upriver and does so for a time period of approximately 30 minutes until slack water. Soon after the flow reversal, peak ebb flow is typically reached within 30 to 60 minutes. Currents measured during peak ebb flow are generally less than peak flood currents. After peak ebb flow, the flow gradually reduces for the remainder of the ebb flow period.

Freshwater flow in the Shubenacadie River is highly variable and dependent on the amount of precipitation over the watershed area. The component of freshwater flow in the river was quantified by assessing salinity measurements at the mouth and in the vicinity of the Project area over a tidal cycle. Approximately one month of continuous salinity data (5-minute sampling) was measured at both sites. During this period of ebb flow, the salinity was usually quite low and the water level remained fairly constant. As an example, at the proposed outfall site, freshwater flows on October 16 and November 6, 2006 were estimated to be no more than 60 and 40 m^3/sec, respectively. Based on monthly freshwater flows computed for the river, very low freshwater flows, less than 3.0 m^3/sec, can occur during the summer months. The largest freshwater flows in the river occur during the spring run-off (April) with mean and maximum monthly flows of 140 m^3/sec and 188 m^3/sec, respectively.

Measurements of salinity in the Shubenacadie River show an Estuary that is strongly influenced by freshwater flow and relatively large tidal forcing. Though the proposed intake and discharge sites are located approximately 20 km upriver of the mouth at Cobequid Bay, a significant mass of salt from the Bay is transported upriver, albeit at lower salinity (generally less than 25 ppt) than the river mouth. Salinity measurements generally show predictable variations over the tidal cycle, such that salinities increase with the rising tide and decrease with the falling tide. Time-series measurements of salinity at the river mouth (Maitland) for the period November 3 to December 7, 2006 are presented in Appendix A.

The salinity signal shows a sudden reduction in salinity after the November 11, 2006 rainfall event (54 mm). Prior to this event, salinity during a six-day period was as high as 27 ppt during flood flow and as low as 15 ppt during ebb flow. However, the large rain event significantly reduced the peak salinity during flood flow by approximately 9 ppt to 18 ppt (mean value of the peaks) for a period of seven days. Salinity peaks gradually increased after this period towards the end of the time-series record. In addition to this reduction in peak salinity during flood flow, ebb flowing water from the River had a greater component of freshwater with minimum salinities as low as 2 ppt. From these results, it is clear that salinity likely varies according to the time of year and freshwater flows. However, the regularity of such variation is not known. *In situ* salinity meters will be installed after ice-break-up in the spring of 2007 to monitor salinity levels in the Estuary throughout the spring, summer and fall. These data will be used to measure the variability in salinity levels on various temporal scales in the Estuary.

5.4 Fish and Fish Habitat

This section describes fish and fish habitat in the Shubenacadie Estuary, with particular emphasis on fish and fish habitat in the vicinity of the proposed location of diluted brine discharge and water withdrawal. Biophysical conditions pertinent to fish and fish habitat have been described based on a review of existing literature and technical reports, consultation with species experts and fieldwork.

5.4.1 Surface Water Quality

The Estuary in the vicinity of the proposed brine discharge and water withdrawal is characterized by variable salinity levels depending on the tide and Estuary levels. Salinity measurements were conducted in the summer and fall of 2006 in the vicinity of the proposed discharge and water withdrawal and are described in Section 5.3.

Erosion of the siltstone, shale cliffs and sea bed by tidal and wave action produce high levels of suspended sediments in the upper Bay of Fundy. Sediments are held in suspension by strong tidal currents and vertical mixing (Shepherd *et al.* 1995). This sediment-laden water penetrates the Estuary and, in addition to overland run-off and *in-situ* erosion processes, contributes to high levels of suspended sediments. The high levels of suspended solids give the water a characteristic reddish brown opaque quality, easily seen in aerial photography of the Estuary (Appendix A). There is a lack of longer-term monitoring data related to suspended sediment levels in the Estuary; however, a sample collected in October 2006 had a Total Suspended Solids (TSS) level of 340 mg/L, and similarly high levels are expected throughout the year.

Water samples were collected on both the flood and ebb tides near the proposed site Project in October 2006 to assess general water quality. Table 5.2 indicates the results of the laboratory analysis.

TABLE 5.2 Chemistry Results of Water Samples

	Units	Flood Tide	Ebb Tide	Detection Limit
Inorganics				
Total Alkalinity (Total as $CaCO_3$)	mg/L	17	15	5
Dissolved Chloride (Cl)	mg/L	84	36	1
Colour	TCU	46	45	5
Hardness ($CaCO_3$)	mg/L	91	73	1
Nitrate + Nitrite	mg/L	0.2	0.2	0.05
Nitrite (N)	mg/L	ND	ND	0.01
Nitrogen (Ammonia Nitrogen)	mg/L	ND	ND	0.05
Total Organic Carbon (C)	mg/L	8	6	5
Orthophosphate (P)	mg/L	ND	ND	0.01
pH	pH	6.95	6.86	N/A
Reactive Silica (SiO_2)	mg/L	3.7	3.7	0.5
Dissolved Sulphate (SO_4)	mg/L	52	43	2
Turbidity	NTU	180	93	0.5
Conductivity	uS/cm	400	230	1
Elements (ICP-MS)				
Total Aluminum (Al)	ug/L	3700	2100	10
Total Antimony (Sb)	ug/L	ND	ND	2
Total Arsenic (As)	ug/L	3	ND	2
Total Barium (Ba)	ug/L	26	16	5
Total Beryllium (Be)	ug/L	ND	ND	2
Total Bismuth (Bi)	ug/L	ND	ND	2
Total Boron (B)	ug/L	54	39	5
Total Cadmium (Cd)	ug/L	ND	ND	0.3
Total Chromium (Cr)	ug/L	5	3	2
Total Cobalt (Co)	ug/L	3	2	1
Total Copper (Cu)	ug/L	5	3	2
Total Iron (Fe)	ug/L	4800	2600	50
Total Lead (Pb)	ug/L	4.8	2.6	0.5
Total Manganese (Mn)	ug/L	320	250	2
Total Molybdenum (Mo)	ug/L	ND	ND	2
Total Nickel (Ni)	ug/L	7	4	2
Total Selenium (Se)	ug/L	ND	ND	2
Total Silver (Ag)	ug/L	ND	ND	0.5
Total Strontium (Sr)	ug/L	140	120	5
Total Thallium (Tl)	ug/L	ND	ND	0.1
Total Tin (Sn)	ug/L	ND	ND	2
Total Titanium (Ti)	ug/L	50	30	2
Total Uranium (U)	ug/L	0.3	0.2	0.1
Total Vanadium (V)	ug/L	9	5	2
Total Zinc (Zn)	ug/L	25	15	5
Elements (ICP-OES)				
Total Calcium (Ca)	mg/L	21	21	0.2
Total Magnesium (Mg)	mg/L	9.3	5.1	0.1
Total Phosphorus (P)	mg/L	0.2	ND	0.1
Total Potassium (K)	mg/L	3.8	2.5	0.1
Total Sodium (Na)	mg/L	40	17	0.2
RCAP CALCULATIONS				
Nitrate (N)	mg/L	0.2	0.2	0.05

Note: Analysis was based on a single water sample collected during the flood (n=1) and ebb tide (n=1).

As expected the sample results indicate high levels of turbidity. Nutrient levels were low during sampling; however, extensive agricultural and residential lands occur along the banks of the Estuary which likely contribute nutrients, in the form of fertilizers as well as human and animal wastes, at certain times of the year.

It is important to note that water quality parameters can change over small spatial and temporal scales and the above testing is a 'snapshot' of water quality during a period of high freshwater runoff and low (<1 ppt) salinity.

5.4.2 Fish Community

The fish assemblage of the Estuary is diverse relative to other watersheds in Nova Scotia, with diadromous (*i.e.,* catadromous and anadromous species), marine, euryhaline, and freshwater fish species contributing to species richness. Anadromous fish are species that are born in freshwater, migrate to the ocean to grow and mature, and migrate back to fresh water to complete their life cycle. In contrast, catadromous fish are species which grow and mature in fresh water and migrate to the ocean to spawn. Euryhaline fish are species which are capable of withstanding a wide range of salinities and are typically found in estuaries. Anadromous fish species present in the Estuary include sea lamprey (*Petromyzon marinus*), Atlantic sturgeon (*Acipenser oxyrhynchus*), brook trout (*Salvelinus fontinalis*), Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), striped bass *(Morone saxatili)*, gaspereau (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), and rainbow smelt (*Osmerus mordax*). The only catadromous species present is the American eel (*Anguilla rostrata*). Marine and euryhaline species that may be present in the Estuary include several stickleback species (Family Gasterosteidae), winter flounder (*Pseudopleuronectes americanus*), smooth flounder (*Pleuronectes putnami*) mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), and Atlantic tomcod (*Microgadus tomcod*). Freshwater fish species present in the Shubenacadie and Stewiacke rivers that are found in the Estuary include chain pickerel (*Esox niger*), yellow perch (*Perca flavescens*), and white perch (*Morone americana*). The spawning periods of these species are shown in Table 5.3.

The Atlantic salmon, striped bass and Atlantic sturgeon are species of concern and thus their protection is of particular regulatory, scientific and public concern. Only the Atlantic salmon is protected by the federal *Species at Risk Act* (*SARA*). However, as NSDNR has "red" listed the Atlantic sturgeon and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has designated the Bay of Fundy population of striped bass as "threatened," the life-history of these aforementioned species and potential interactions with the Project are discussed in more detail than fish species in the Estuary that have no special status. The life-history pattern of Atlantic salmon, striped bass and Atlantic sturgeon are discussed separately below in Section 5.4.5.

The following text provides a brief overview of the natural history of the fish species likely present in the Estuary.

The sea lamprey is a large, eel-like anadromous species which is present in the Shubenacadie and Stewiacke Rivers. The sea lamprey lacks an ossified skeleton and is considered a primitive chordate, distantly related to the teleost (bony) fishes. The sea lamprey is present in the Estuary during migrations to spawning grounds above the head of tide. Adult sea lampreys likely congregate in the Estuary during late winter and start to move upstream at night, following the onset of warming water temperatures; however, spawning does not occur until late May or early June. Lampreys spawn in areas of gravel and cobble bottoms of shallow reaches of rivers with adjacent quiescent, muddy areas for the development of larvae. Lamprey larvae are called ammocoetes and are benthic filter feeders that burrow in muddy substrates. Metamorphosis to the adult stage occurs after 4 to 7 years at which

time the juvenile lampreys descend to the sea to feed. Adult lampreys are predaceous parasites, attaching to pelagic fish, sharks and marine mammals with their raspy suckers and feeding on blood and muscle tissue. Lamprey attacks on smaller fish (*i.e*., salmon, striped bass and groundfish) are often fatal and for this reason the sea lamprey is disdained by commercial and recreational fishers. No commercial fishery exists for sea lamprey in Atlantic Canada.

TABLE 5.3 Spawning times of fish species which occur in the Estuary (Scott and Crossman 1973)

Species	January	February	March	April	May	June	July	August	September	October	November	December
sea lamprey												
Atlantic sturgeon												
brook trout												
Atlantic salmon												
brown trout												
striped bass												
gaspereau												
blueback herring												
American shad												
rainbow smelt												
American eel	No spawning in area											
stickleback species												
winter flounder	No spawning in area											
smooth flounder	No spawning in area											
mummichog												
Atlantic silverside												
Atlantic tomcod												
chain pickerel												
yellow perch												
white perch												

Spawns in Estuary

Spawns in freshwater

Anadromous and freshwater brook trout populations exist in Nova Scotia. Fish present in the Estuary are likely anadromous fish and although most abundant during migrations, may be present at other times of the year. Brook trout in freshwater prefer well-oxygenated, clear, cool waters with gravel beds in shallow headwaters of streams and lakes with upwellings and/or currents for spawning. Brook trout are iteroparous and generally spawn in Nova Scotia in late September, October, or early November. Iteroparity refers to the life history trait of some species where individual organisms typically reproduce repeatedly in a lifetime. Movements of anadromous populations from freshwater to marine habitats are variable; however, fish typically descend to the sea from late April to early June, remain at sea for an average of two months, and then return to their natal river or stream for spawning. While at sea brook trout do not undertake long-range migrations, instead individuals generally remain in the lower reaches of estuaries and shallow, coastal waters. While at sea brook trout feed primarily on small fishes and in freshwater they consume a wide variety of aquatic invertebrates, fish and even mice and frogs (Scott and Crossman 1973). Sea-run brook trout generally grow at a more rapid rate and achieve greater sizes as compared to fish that never leave freshwater. The brook trout is an excellent game fish and is sought after by recreational anglers in Nova Scotia. It is by-far the most common salmonid in Nova Scotia; however, NSDNR lists the brook trout as “yellow”, meaning that is it is sensitive to anthropogenic stressors. Indeed, brook trout populations have been decimated in many watersheds due to a combination of factors such as low pH, siltation, and destruction of riparian vegetation and instream habitat and introduction of non-native, predatory fishes (*i.e*., chain pickerel).

The presence of brown trout is difficult to confirm in the Shubenacadie and Stewiacke Rivers. The brown trout is an introduced species from Europe which was released in Nova Scotia as a sport fish. Although regular stocking of this species has been discontinued, populations persist in several watersheds. Brown trout spawn in the late fall to early winter in shallow gravely headwaters of streams and return to the sea to feed. However, the specific life-history patterns of brown trout in Nova Scotia are unknown, although they likely do not travel far from the estuaries of their natal rivers. Brown trout are popular among recreational anglers wherever they occur.

Gaspereau are anadromous and are present in the Estuary during spawning migrations and when juvenile fish descend to the sea. Gaspereau ascend rivers in early spring and begin to spawn in late April in lakes, ponds, rivers and streams above the tide head and spawning may last for two months (Scott and Scott 1988). Gaspereau feed primarily on zooplankton as both adults and larvae. The young gaspereau feed and grow in the river during the summer and descend to the sea during the fall. Gaspereau, while not highly valued, are fished commercially in eastern Canada. A commercial and Aboriginal fishery is present on the Shubenacadie River using fences and dip-nets and gill-nets with fishing occurring during the spring spawning run of fish. The gaspereau is still abundant in many watersheds; however, NSDNR classifies the gaspereau as a “yellow” listed species, as it is sensitive to human activities during freshwater life stages and easily depleted by fishing during spawning runs.

The blueback herring is similar in appearance to the gaspereau, discernible from the latter species only by close examination and dissection. Blueback herring are anadromous; however, specific information regarding spawning locations is unknown with some authors reporting a preference for brackish water while others report spawning in freshwater (Scott and Crossman 1973). The blueback herring is present in the Shubenacadie-Stewiacke watershed and is likely present in the Estuary during spawning migrations and when juvenile fish descend to the sea. Blueback herring feed on plankton, copepods,

pelagic shrimp, fish fry, eggs, and larvae. Blueback herring are likely caught along with gaspereau during spawning runs, but are not identified to species.

The American shad is another anadromous species that is present in the Shubenacadie-Stewiacke watershed which passes through the Estuary during spawning migrations and when juvenile fish descend to the sea. The American shad is highly migratory and forms large schools while at sea. Adult fish enter freshwater during the spring and typically begin to spawn from May to July when water temperatures are 16.9-19° C (Scott and Scott 1988). Shad spawn above the head of tide, typically in rivers and larger streams and rarely in lakes. Shad are iteroparous, returning to their natal streams each year to spawn. Juvenile shad move downstream to brackish water and remain in estuarine environments until they are 50-75 mm in length, upon which they leave the Estuary and enter the ocean. The movements and life history of American shad at sea are poorly known, although they are believed to travel long-distances and spend most of their time in deep water, perhaps making vertical migrations to the surface at night. However, adult shad are also known to congregate and feed in shallow-waters of inner Bay of Fundy. Adult shad are plankton feeders, and young fish in freshwater eat copepods, crustacean zooplankton, and aquatic insect larvae. Shad are harvested with gill nets, trap nets, scoop nets, and weirs in the Bay of Fundy. A seasonal gill net fishery takes place in the Cumberland Basin at the head of the Bay of Fundy and in the Petitcodiac River. There is also a recreational shad fishery in the Shubenacadie and Stewiacke rivers in the spring during their spawning run.

American (Rainbow) smelt are a small anadromous species that spawn in the Shubenacadie and Stewiacke Rivers as well as their tributaries and are present in the Estuary during spawning migrations and likely during the winter months when they are preparing to ascend to their spawning grounds. Smelt live in schooling populations that prefer midwaters of lakes and inshore coastal waters and do not inhabit flowing waters outside of the spawning period (Scott and Crossman 1973). Smelt demonstrate temperature and light sensitivity, with preferences for colder and darker waters. Smelt feed on amphipods, euphausiids, ostracods, mysids, shrimp, and aquatic worms. During spawning migrations, smelt are harvested recreationally, as the species is considered an excellent food fish. Smelt are important prey for predatory fish, mammals and birds (Scott and Crossman 1973).

American eel are catadromous, entering freshwater early in development and returning to salt water to spawn as adults. American eel are likely present in the Estuary throughout the year, with higher numbers of young eels (elvers) found in the Estuary during the spring. American eels are semelparous with spawning believed to occur in deep water in the vicinity of the Sargasso Sea in the sub-tropical Atlantic. Semelparity refers to the life history trait of some species where individual organisms reproduce only once during a lifetime and typically die immediately after reproducing. Small, transparent elvers (65-90 mm long) enter Canadian coastal rivers in May and June and disperse to a wide variety of estuarine and freshwater habitats, including rivers, streams, ponds and lakes (Scott and Scott 1988). Indeed, eels can make brief overland movements in wet weather, therefore eels are often found in waterbodies not directly connected to the sea. Eels become sexually mature after several years in freshwater or estuarine environments upon which they move downstream to commence their migration to the mid-subtropical Atlantic to spawn. Eels are carnivorous and feed mainly on bottom invertebrates and small fishes in freshwater. In the Maritimes, eel traps, baited pots, weirs, and hoop nets are used to catch eels.

Stickleback species are present in the Estuary. As a group, sticklebacks have a wide range of salinity tolerance, from freshwater to seawater. They are predators and feed on small invertebrates, small fish, and fish eggs. Early spring spawning takes place near intertidal vegetation. Sticklebacks are an important prey species for other predaceous fish (Scott and Scott 1988).

Winter and smooth flounder may be found in the Estuary, likely ascending the Estuary during the flood tide to feed. The winter flounder is mainly a marine benthic species but is occasionally found in estuaries or freshwater. The smooth flounder closely resembles the winter flounder and frequently ascends rivers into weakly saline or fresh waters. Flounders are carnivorous, preying primarily on polychaete worms, small crustaceans, and mollusks. Winter and smooth flounders spawn in saltwater. The winter flounder is a commercial and recreational species in the upper reaches of the Bay of Fundy; however, they are not fished in the Estuary. The smooth flounder is of no commercial interest, due to its small size, although it is frequently taken as bycatch in smelt fisheries.

Atlantic tomcod is an inshore, shallow water, euryhaline fish species that moves upriver to the tide head in late fall or early winter for spawning. Tomcod are likely present in the Estuary throughout the year and may spawn in the area of the proposed discharge and water withdrawal. Depending on freshwater flow and tides, salinity may vary at the spawning site and range from 1-4 ppt to 25-30 ppt (Scott and Scott 1988). Tomcod eggs require a freshwater influx during development and do not develop normally when continuously exposed to 30 ppt salinities (Peterson *et al.* 1980). Tomcod feed on small crustaceans, such as amphipods (*Gammarus* sp.) and shrimp (*Crangon* sp.), as well as marine worms, molluscs, and other fish. Tomcod are not fished commercially in the Estuary; however, they are taken as bycatch in a variety of other fisheries and are frequently caught by recreational anglers in estuaries and coastal areas.

Mummichogs are small, minnow-like fish that are found in brackish and coastal waters, and occasionally freshwater. They are likely present in the Estuary throughout the year. Mummichogs are frequently present in large numbers in Nova Scotian estuaries and saltmarsh habitats and are able to thrive in conditions (*i.e.,* widely fluctuating salinities and temperature) that would kill most other fish species. Spawning occurs during the spring and summer; however, some reports indicate that the period can be restricted to a few weeks in June and early July. Preferred prey of mummichogs includes amphipods, diatoms, crustaceans, molluscs, fish eggs, and eel grass (Scott and Crossman 1973).

Atlantic silverside is a small, schooling species that occurs in coastal marine, brackish and freshwater environments. Silversides occur in the Estuary in the spring, summer and fall and anecdotal reports suggest that silversides reach their peak of abundance in late summer in the upper Bay of Fundy and adjoining estuaries. Silversides are found near sandy and gravely shores or near sedge grass at high tide and tend to follow the tides up and down beaches and frequent brackish waters for foraging. During the winter month's silversides likely migrate to deeper, coastal waters. Spawning usually occurs in May, June, and July. Silversides are omnivorous and feed on copepods, mysids, shrimps, amphipods, fish eggs, worms, algae, diatoms, insects, and mollusc larvae (Bigelow and Schroeder 2002). Silversides are an excellent forage species for striped bass and other predatory fish, and likely comprise an important component in the diet of predatory fish in areas where silversides are abundant. Silversides are not harvested commercially in the Bay of Fundy or the Estuary.

Chain pickerel is an introduced, freshwater species. Chain pickerel are common in the Shubenacadie-Stewiacke watershed but are likely not commonly found in the vicinity of the proposed diluted brine

discharge and water withdrawal in the Estuary as their tolerance for high salinity is limited. However, in the eastern United States this species is known to penetrate into brackish waters (Scott and Crossman 1973) and may be present in the Estuary during the ebb tide when salinities are lowest. Chain pickerel is a nuisance species in Nova Scotia due to the damage it exerts on populations of native species due to predation and, to a lesser extent, competition. Chain pickerel spawn during early spring immediately after ice melt in shallow waters of streams, lakes, or ponds. Pickerel are a solitary fish that hide most of their life in vegetation, from where they can ambush a variety of prey in such as frogs and minnows (Scott and Crossman 1973).

Yellow perch is a widely distributed species in freshwater systems and can be found in brackish waters and may be present in the Estuary during ebb tides when salinities are lowest. Yellow perch are a highly adaptable species and can tolerate a wide variety of conditions in terms of temperature, salinity, light, oxygen, and pH. Yellow perch migrate towards shallow waters of lakes and rivers to spawn in the spring. Spawning does not occur in brackish waters. Yellow perch prey on insects, invertebrates, and small fish. This species is of minor importance to recreational fisheries and is not targeted commercially in Nova Scotia, although it is fished commercially in other areas of Canada.

White perch is found in both in brackish and fresh waters and is likely present in the Estuary. White perch spawn from April through June in fresh to low-salinity waters of large rivers over fine gravel or sand. No data are available to conclude if spawning of white perch occurs in the Estuary in the vicinity of the proposed diluted brine discharge and water withdrawal, although it is likely that salinities are higher than the optimal range for this species. White perch is a highly adaptable, predaceous species that feeds on a wide variety of insects, crustaceans, mollusks, oligochaetes, larvae, and small fish. It is known to form schools and often occurs at high densities in suitable habitat. No commercial or intense recreational fishery has developed in eastern Canada for white perch.

The planktonic life stages of bony fishes (eggs and larvae) are likely to be more sensitive to fluctuations in salinity than adult fish due to the inability of drifting larvae and eggs to actively move from areas of contamination and physiological sensitivities. Mummichogs, sticklebacks and Atlantic tomcod likely spawn in the Estuary in the vicinity of the Project area and striped bass larvae and eggs are present at certain times of the year. Mummichogs and sticklebacks are typically found in shallow coastal waters, estuaries and salt marshes and have evolved to deal with fluctuations in salinity levels greater than 25 ppt. Sensitive life stages of Atlantic salmon (eggs and alevins) and sturgeon (eggs and larvae) are not known to occur in the Estuary thus limiting interaction with discharge.

5.4.3 Benthic Communities

Benthic microalgae are typically abundant on mudflats in the inner Bay of Fundy and adjacent estuaries and are an important element of the ecosystem as they are major contributors to primary productivity and stabilize mudflats. The most important group of microalgae in the region is the diatoms, which are single-celled, photosynthetic organism that have hard, silica-based shells. Benthic microalgae are found only in the top centimeter of mud where oxygen and light allow them to photosynthesize. A variety of species are likely present in the mudflats in the area of proposed diluted brine discharge and water withdrawal.

The tube-dwelling amphipod, *Corophium volutator*, is the dominant invertebrate species in most areas of the inner Bay of Fundy (Hicklin 1981, Gratto 1979) and is likely present in the Estuary. *C. volutator* is

a significant keystone species in the intertidal ecosystem, providing an essential food source for a variety of shorebirds and fishes (Shepherd *et al.* 1995). In North America, this species occurs only in the Bay of Fundy (Environment Canada 1994), although it is widespread on European mudflats. *C. volutator* prefers sheltered conditions and is not found in conditions of heavy pollution, sand lacking abundant detritus, or sulphide mud which is blackened by excessive organic detritus (McLusky 1967). *C. volutator* lives in U-shaped burrows which penetrate up to 6 cm in the mudflats. In the Bay of Fundy, *C. volutator* feeds on mud containing bacteria, diatoms and other benthic microalgae, macroalgae organic detritus, and detritus from *Spartina alterniflora* (Murdoch *et al.* 1986). The population density of *C. volutator* varies considerably within a year at any particular location as the species produces two generations each year, one in early June and the other late summer (Peer *et al.* 1986, Gratto 1979). Predation exerts a strong influence on the abundance of *C. volutator*, for example a single sandpiper feeding at the edge of the ebbing tide can consume up to 50 *C. volutator* per minute (Boates 1980). A flock of 1,000 birds feeding in a one hectare area can consume approximately 250,000 *C. volutator* in five minutes (Boates *et al.* 1995).

The diversity and abundance of other benthic invertebrates is not known in the Estuary in the vicinity of the proposed diluted brine discharge and water withdrawal. Substrates consist of sands and mud thus the benthic community is likely dominated by infaunal organism, which are organisms that live the majority of their lives buried in the sediment as opposed to those that live at the sediment surface or in the water column. For instance, a variety of worm species may be present and include segmented annelid polychaetes, and slender nemerteans, or round worms. Soft-shelled (*Mya arenaria*) and macoma (*Macoma baltica*) clams are common in the inner Bay of Fundy, although respective abundance in the Estuary at the site of diluted brine discharge and water withdrawal are not known.

5.4.4 Aquatic and Marine Related Mammals

Several mammal species that occur in the vicinity of the proposed diluted brine discharge and water withdrawal depend on fish as their primary food source and are thus closely linked to the aquatic environment of the Estuary. These include river otter (*Lutra canadensis*) and mink (*Mustela vison*). Otter and mink are relatively common throughout Nova Scotia; although these top predators typically have high levels of contaminants in their tissues which may be having reproductive effects.

Marine mammals from the Bay of Fundy occasionally enter the Estuary, likely in pursuit of schooling fish. The most frequent visitor is the harbour seal (*Phoca vitulina*). Harbour seals have been known to travel as far as Grand Lake. Harbour porpoises (*Phocoena phocoena*) also venture into the Estuary on occasion.

5.4.5 Species of Concern

Several at-risk fish species are present in the Shubenacadie watershed and protection of these populations and their habitats is of key concern. NSDNR has “red” listed three fish species present in the Estuary including Atlantic salmon, striped bass and Atlantic sturgeon. The Inner Bay of Fundy population of Atlantic salmon is listed as endangered on Schedule 1 of *SARA*. The Bay of Fundy population of striped bass is designated as threatened by COSEWIC but has yet to be listed under *SARA*.

Atlantic salmon is an anadromous species that requires large cool, clean rivers for spawning and rearing. Adults ascend their natal rivers in summer and spawn in gravely head-water areas in October and November. Atlantic salmon are capable of iteroparity; however, many succumb to predators and physiological stress during spawning and migration. Female salmon construct nests (redds) by sweeping a depression in gravel with their caudal fins. After depositing her eggs, which are fertilized by a male, the female covers the eggs with gravel. Salmon eggs hatch in April, depending on water temperature, and the young (alevins) remain in the gravel until May or June. Smolts migrate to sea when they reach approximately 15 cm in length after a period of about three years in freshwater, live at sea for a year or two, and then return to their natal rivers to complete the life cycle (Scott and Scott 1988). The food of young salmon in freshwater consists of larva aquatic insects such as blackflies, stoneflies, caddisflies, and chironomids. At sea, salmon eat a variety of organisms including plankton, amphipods, decapods, and other fish such as herring, gaspereau, smelts, capelin, sand lance and small cod. It is thought that the Inner Bay of Fundy population of Atlantic salmon remains in the Bay and the Gulf of Maine during marine life stages. The Estuary does not provide spawning habitat for salmon. Nonetheless, the Estuary is used during migration, while salmon are ascending the Shubenacadie and Stewiacke rivers to spawn or when smolts and adults are returning to sea. During migrations, Atlantic salmon do not move directly into seawater but stage in the Estuary for at least one tidal cycle (Tytler *et al.* 1978), likely to make physiological adjustments to cope with changing concentrations of salinity.

Atlantic salmon populations in the Inner Bay of Fundy are in a precarious state. According to recent estimates, the entire inner Bay of Fundy population of Atlantic salmon consists of about 100 mature individuals (COSEWIC 2006). Furthermore, data indicates declines in returning, spawning fish of approximately 95% in the past thirty years (COSEWIC 2006). The reasons for the precipitous decline are not definitively known and are likely multi-factoral. It appears that declines are occurring at sea as adult fish are not returning to spawn even though smolt production remains stable in most rivers. Factors that have caused and/or exacerbated this decline may include ecological changes in the Bay of Fundy, such as those brought about by tidal barriers in several rivers and streams. In addition, commercial salmon farms may attract predators, alter habitat, obstruct migration and/or harbour disease, all of which could impact Atlantic salmon. Escapees of domesticated stock used in aquaculture may be breeding with indigenous, wild fish and resultant hybrids could have decreased fitness, affecting survivorship while at sea and resistance to pathogens. As causative factors are not definitively known, the protection of the remaining spawning adults is difficult. Nonetheless, it is clear that any human-induced mortality of spawning individuals compromises the likelihood of recovery of the Bay of Fundy population of Atlantic salmon. As an endangered species listed on Schedule 1 of *SARA*, all individual Inner Bay of Fundy Atlantic salmon are protected, as is their habitat.

Another anadromous species of special interest present in the Estuary is the striped bass. Only two river systems in Atlantic Canada are currently known to support spawning populations, the Miramichi River in New Brunswick and the Stewiacke River. Striped bass are known to overwinter in the Shubenacadie River Estuary while spawning in the Stewiacke River Estuary occurs from late May to early June (Douglas *et al.* 2002, Duston *et al.* 2004). Males reach the spawning grounds before females. As spawning occurs, several males surround a single female as she broadcasts her semibuoyant eggs near the water surface where fertilization occurs. Striped bass do not spawn in the Estuary in the vicinity of the Project area as salinities in this area are higher than preferred spawning salinities. For example, successful spawning was observed in the Chesapeake and Delaware Canal at

salinities of only 0.70 to 1.5 ppt (TDS) by Johnson and Koo (1975) and Stevens (1979) reported that striped bass may not spawn where salinities exceed 5 ppt. The salinity in the Estuary in the vicinity of the proposed Project fluctuates between 1 and 27 ppt, precluding successful spawning. Spawning in the Shubenacadie takes place farther upstream at the head of tide, where salinity levels are in the vicinity of 0.2 ppt (T. Duston, pers. comm. 2006).

Striped bass are voracious and opportunistic feeders, consuming zooplankton, shrimp, and crustaceans while young, and a variety of fish and large invertebrates, such as crab, lobster and squid, as adults (Scott and Scott 1988). The Estuary in the vicinity of the proposed site of diluted brine discharge and water withdrawal provides foraging and migratory habitat for striped bass. In addition, eggs and larvae may be present at high numbers during the spawning season (R. Bradford, pers. comm. 2007).

The striped bass population in the Estuary is thought to be genetically distinct with little to no gene flow from other populations and thus represents a unique evolutionary unit. A loss of individuals from the Shubenacadie and Stewiacke Rivers is considered to be significant to the overall genetic health and intraspecific diversity of the metapopulation (Douglas *et al.* 2002). The population number in the Shubenacadie and Stewiacke rivers is not known. Threats to striped bass include decreased water quality, commercial and recreational fishing pressure, and ecological changes brought about by industrial and residential development as well as dams and other alterations to rivers. However, local fishers report the striped bass to be very common in the Estuary (Local fishers reported at open house, November 2006).

Atlantic sturgeon is a bottom-dwelling species that migrates in spring or early summer from the sea to freshwater for spawning. During spawning, the eggs are broadcast over a large area and left unattended to hatch in eight to ten days. A large female sturgeon can lay as many as two million eggs. Spawning occurs in flowing water at the juncture of fresh and saltwater. Sturgeon eggs, which are highly adhesive, are deposited on the bottom, usually on hard surfaces (*i.e.,* cobble). Hatching occurs approximately 94-140 hours after egg deposition (Smith *et al.* 1980). The yolksac larval stage is completed in about 10 days, after which the young assume a demersal existence. Juvenile sturgeon are thought to gradually move downstream into brackish waters, and remain resident in estuarine waters for months or years before migrating to salt water. Adult sturgeons are occasionally reported from Grand Lake; however, most adults spend the majority of their lives at sea where their movements are poorly understood. In freshwater, young fish eat bottom plants, insect larvae, small crustaceans and molluscs, while adults eat molluscs, worms, crustaceans, and small fish. Mature sturgeon do not feed during migration and spawning. The Estuary in the vicinity of the proposed site of diluted brine discharge and water withdrawal likely provides foraging and migratory habitat for Atlantic sturgeon, with spawning likely occurring further upstream at the head of tide.

Sturgeon are slow growing and late to mature, rendering them particularly vulnerable to intense exploitation. Coupled with the effects of water degradation and dams that have prevented fish from reaching their upstream spawning grounds, sturgeon populations in Atlantic Canada and the eastern United States have been depleted. Existing fisheries for sturgeon are small-scale in Atlantic Canada; however, larger numbers are likely taken as bycatch at sea in gillnets and weirs. Although no impediments to sturgeon movement currently exist on the Shubenacadie and Stewiacke rivers, obstructions (*i.e.,* dams) in other Bay of Fundy rivers have likely affected the populations.

5.5 Rare and Sensitive Flora

From the ACCDC search, 132 rare or uncommon plant species have been recorded within a 100 km radius of the proposed Project facilities. These are listed in Table I1 in Appendix I. The likelihood of each species being present along areas potentially affected by Project activities was assessed using habitat modeling. The habitat preferences of each species were compared to the types of habitats present in the proposed Project footprint. The habitats present within the proposed Project footprint were derived from field observations as well as existing data sources including aerial photography, forest inventory mapping and surficial geology mapping.

The results of the habitat modeling indicate that there is some potential for 76 uncommon or rare plant species to be present within the Project footprint. None of these species is listed under the *SARA*or the Nova Scotia *Endangered Species Act*. Twenty of the species are "red" listed by NSDNR indicating that they are known to be at risk or are thought to be at risk. Forty-nine of the species are "yellow" listed indicating that they are sensitive to human activities or natural events. Four species are listed by NSDNR as status "undetermined" indicating that there is insufficient data to assign a population status at the present time. These species are typically species that are easily overlooked, species for which there is difficulty in distinguishing the rare species from a closely related common species or species whose taxonomy is in a state of flux. Three of the species have no NSDNR population status. These are typically species that have only recently been discovered in the province.

It is highly unlikely that all of the 76 species that could potentially be present within the Project footprint are actually present. Based on the results of the habitat modeling and the experience of our botanists in this area, there are 10 vascular plant species that are most likely to be present within the Project footprint. These species are listed in Table 5.4 and include marsh bellflower (*Campanula aparinoides*), a sedge (*Carex houghtoniana*), purple-leaf willowherb (*Epilobium coloratum*), meadow horsetail (*Equisetum pratense*), black ash (*Fraxinus nigra*), downy rattlesnake plantain (*Goodyera pubescens*), clammy hedge-hyssop (*Gratiola neglecta*), wood nettle (*Laportea canadensis*), Canada lily (*Lilium canadense*), and northern bog violet (*Viola nephrophylla*).

TABLE 5.4 Rare or Uncommon Vascular Plants Documented Within 100 km of Project Area that are Most Likely to be Found in the Project Area

Latin Name	Common Name	Preferred Habitat	Season Best to Identify	ACCDC RANK	NSDNR RANK
Campanula aparinoides	Marsh Bellflower	Meadows, ditches and river banks.	August	S3?	YELLOW
Carex houghtoniana	A Sedge	Sandy soils and roadside banks.	Seeds (perigynia) required for identification. Can be identified from May through September.	S2?	UNDETERMINED
Epilobium coloratum	Purple-leaf Willowherb	Low-lying ground, springy slopes and similar locations.	July and October. Seeds required for identification.	S2?	YELLOW
Equisetum pratense	Meadow Horsetail	Grassy stream banks.	Coning in May and June, identifiable through growing season.	S2	YELLOW

TABLE 5.4 Rare or Uncommon Vascular Plants Documented Within 100 km of Project Area that are Most Likely to be Found in the Project Area

Latin Name	Common Name	Preferred Habitat	Season Best to Identify	ACCDC RANK	NSDNR RANK
Fraxinus nigra	Black Ash	Low ground, damp woods and swamps.	May and June. Can be identified without flowers.	S3	YELLOW
Goodyera pubescens	Downy Rattlesnake Plantain	Coniferous woods, often growing on moss.	July to August.	S1	RED
Gratiola neglecta	Clammy Hedge-Hyssop	Muddy places, wet ground.	June to September.	S1	YELLOW
Laportea canadensis	Wood Nettle	Alluvial woods of mixed or deciduous trees. Floodplains on the Cape Breton plateau. Only in the most fertile locations.	July to September. Can be identified without flowers.	S3	YELLOW
Lilium canadense	Canada Lily	Rich river or stream intervale meadows and forest.	Flowers in July but identifiable from May to October.	S2S3	YELLOW
Viola nephrophylla	Northern Bog Violet	Cool mossy bogs, the borders of streams, and damp woods.	May to July. Best identified in flower.	S2	YELLOW

Atlantic Canada Conservation Data Centre (ACCDC) General Status Ranks	
S1	Very Rare
S2	Rare
S3	Uncommon
S4	Fairly Uncommon
SE	Exotic
Note: A combination of S ranks (*e.g.* S3S4) or the presence of a question mark denotes uncertainty regarding the population status of species	
Nova Scotia Department of Natural Resources (NSDNR) General Status Ranks	
Blue	Extinct
Red	Known to be or thought to be at risk
Yellow	Sensitive to human activities or natural events
Undetermined	Insufficient data exists to assess status
Green	Secure

Source: ACCDC 2005; NSDNR 2002; Roland and Zinck 1998

In addition to the 100 km radius modeling, all uncommon or rare plant species documented within a 10 km radius of the Project were compiled. Given, the close proximity of these records to the Project area, the probability of these species being present is higher than for those derived from the 100 km radius modeling, provided appropriate habitat is present along the proposed pipeline route. These species are listed in Table 5.5.

TABLE 5.5 Rare or Uncommon Vascular Plants Documented Within 10 km of Project Area

Latin Name	Common Name	Preferred Habitat	Season Best to Identify	Likelihood on Site	ACCDC RANK	NSDNR RANK
Anemone quinquefolia var. quinquefolia	Wood Anemone	Wooded riverbanks and shaded intervales.	Late May to early June.	Possible	S2	YELLOW
Anemone virginiana	Virginia Anemone	Rocky or dry, open woods.	June to July.	Unlikely but possible	S1S2	YELLOW
Carex hirtifolia	Pubescent Sedge	Calcareous regions, in meadows and thickets, forest slopes.	Seeds (perigynia) required for identification. Can be identified from May through September.	Unlikely	S1S2	RED
Carex houghtoniana	A Sedge	Sandy soils and roadside banks.	Seeds (perigynia) required for identification. Can be identified from May through September.	Likely	S3?	YELLOW
Caulophyllum thalictroides	Blue Cohosh	Deciduous and intervale forest.	April to early June. Can be identified when not in flower into October.	Unlikely	S2	RED
Dirca palustris	Eastern Leatherwood	Low wet woods, streambanks, rich wooded slopes.	March to April.	Unlikely	S1	RED
Gratiola neglecta	Clammy Hedge-Hyssop	Muddy places, wet ground.	June to September.	Likely	S1	YELLOW
Lilium canadense	Canada Lily	Rich river or stream intervale meadows and forest	Flowers in July but identifiable from May to October.	Possible	S2S3	YELLOW
Sanicula odorata	Black Snake-Root	Rich, alluvial woods and along intervales.	July to August.	Possible	S1	RED

Likelihood on Site	
Unlikely	Very low probability due to likely absence of suitable habitat, or dispersability limitations combined with lack of nearby known populations.
Unlikely but possible	Low probability due to likely absence of suitable habitat or dispersability limitations combined with lack of nearby known populations, but with more potential than above.
Possible	Medium probability due to more proximal known populations, better dispersability and greater chance apparent existing habitats could hold these species.
Likely	High probability of encountering these species in habitats possibly present in the study area.
Atlantic Canada Conservation Data Centre (ACCDC) General Status Ranks	
S1	Very Rare
S2	Rare
S3	Uncommon
S4	Fairly Common
SE	Exotic
Note: A combination of S ranks (*e.g.* S3S4) or the presence of a question mark denotes uncertainty regarding the population status of species	
Nova Scotia Department of Natural Resources (NSDNR) General Status Ranks	
Blue	Extinct
Red	Known to be or thought to be at risk
Yellow	Sensitive to human activities or natural events
Undetermined	Insufficient data exists to assess status
Green	Secure

Source: ACCDC 2005; NSDNR 2002; Roland and Zinck 1998

There are three species that are found in both Tables 5.4 and 5.5 indicating that there is a high probability that suitable habitat is present along the route and that these species have been recorded in close proximity to the proposed pipeline route. These species include sedge (*Carex houghtoniana*), clammy hedge hyssop and Canada lily. These three species would have the highest probability of occurring along the route. The results of the modeling exercise suggest that riparian habitats (including stream banks and riparian forest), rich forest habitat and certain disturbed areas such as roadsides are the habitats in the area of the proposed pipeline that have the greatest potential to harbor uncommon or rare vascular plant species.

Two field surveys were conducted along the proposed pipeline route and in the vicinity of the diluted brine discharge site. One survey was conducted between June 27 and 29, 2006 and the other was conducted on August 9, 10, 11, 14 and 17, 2006. A list of the 356 vascular plant species found along the survey route is presented in Table I2 in Appendix I. Nine species listed as uncommon or rare by ACCDC were encountered during the field surveys. These included yellow-seed false-pimpernel (*Lindernia dubia*) (S2), crowded sedge (*Carex adusta*) (S2S3), green sedge (*Carex houghtoniana*) (S3?), alderleaf buckthorn (*Rhamnus alnifolia*) (S3), Bicknell northern crane's-bill (*Geranium bicknellii*) (S3), variegated horsetail (*Equisetum variegatum*) (S3), bushy knotweed (*Polygonum ramosissimum*) (S3S4), tropical saltbush (*Atriplex littoralis*), and retrorse sedge (*Carex retrorsa*) (S3S4). Three of these species, crowded sedge, green sedge and alderleaf buckthorn are "yellow" listed by NSDNR indicating that their populations in Nova Scotia are sensitive to human activities or natural events.

The remaining five species are "green" listed by NSDNR indicating that their populations in Nova Scotia are believed to be secure.

Alderleaf buckthorn was found in a large clearcut located approximately 300 m east of the point where the proposed pipeline crosses Highway 102 (Figure 5.2). Approximately 50 alderleaf buckthorn plants were found at this location. One alderleaf buckthorn was found inside the RoW and would be lost to construction activity. Three were found near the edge of the RoW and could potentially be lost to construction activity. The remaining plants were found outside of the RoW and are unlikely to be affected by construction of the proposed pipeline.

Crowded sedge and green sedge were found in similar habitat which consisted of areas of exposed mineral soil in clear cuts. Both species tended to occur most frequently on skidder trails and along woods roads where mineral soil was exposed. Green sedge tended to be found on the drier sandier sites than crowded sedge which was typically associated with more mesic areas. In two out of nine sites where one of these species was encountered, both species were found together (Figure 5.2). It was very difficult to assess the abundance and distribution of crowded sedge since it was typically associated with another much more common sedge species, clustered sedge (*Carex cumulata*). Both of these sedges belong to a tribe within the genus *Carex* known as the *Ovales* to which belong 16 species that are found in Nova Scotia. It is extremely difficult to differentiate these species in the field. In most instances where large numbers of clustered sedge were present, a few crowded sedges were detected. It is therefore unlikely that the field survey provides an accurate assessment of the abundance and distribution of this species.

Green sedge was recorded at six locations along the proposed RoW. Two of these patches are located inside the proposed RoW and would be lost as a result of construction activity. Three patches of green sedge are located at the edge of the RoW and could be affected by construction. One patch is located outside of the proposed RoW and would not be affected by construction activity. Crowded sedge was recorded at five locations, two of which are located in the proposed RoW and three are located at the edge of the RoW. Given the habitat preferences of these species, it is likely that they are widely distributed in the large clear-cuts within which they were found.

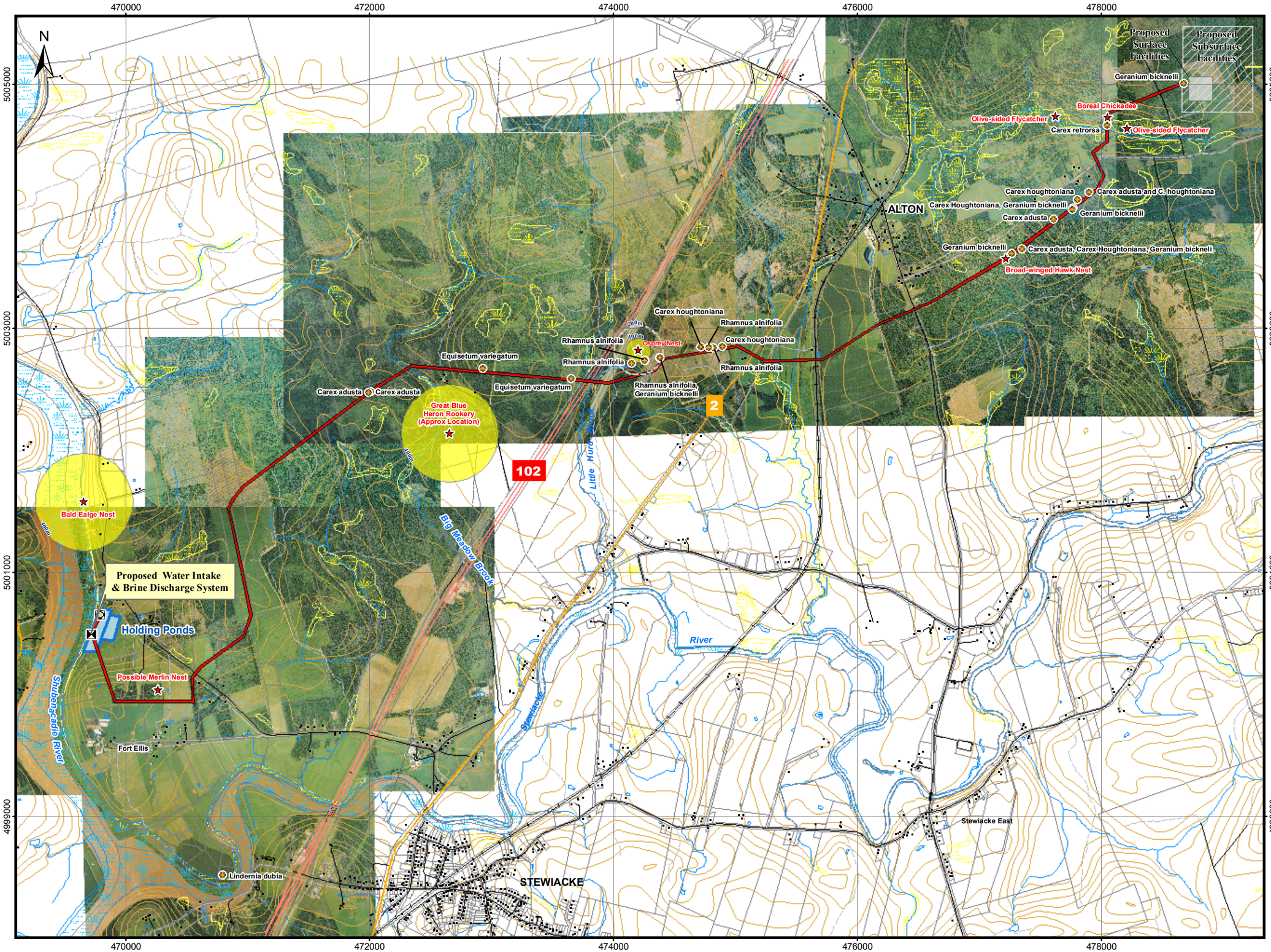


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Figure 5.2
Bird Habitat & Rare Plant Locations

Map Features

- Bird Habitat
- Rare Plant Locations
- NSDNR Guidelines Buffer
- Suggested Osprey Nest Buffer
- Building (1997, NSTS, 10k)
- Water Intake
- Brine Discharge
- Proposed Pipeline Route (20m ROW)
- Holding Ponds
- Proposed Surface Facilities
- Proposed Subsurface Facilities
- Bridge
- Major Highway
- Collector Highway
- Paved Road
- Unpaved Road
- Rail
- Utility Line
- Contour (5m)
- Watercourse
- Waterbody
- Property Boundary

NSDNR Delineated Wetland

- NSDNR Freshwater Wetland
- NSDNR Saltwater Wetland

Air Photos: Nova Scotia Aerial Photography, 2004

0 250 500 1,000
Metres

Map Parameters
Projection: UTM, NAD83, Zone 20
Scale 1 : 30,000
Date: June 06th, 2007
Project No.: 1012229.

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Four of the species considered to be uncommon by ACCDC and are considered to be secure by NSDNR were found in disturbed habitats along the proposed pipeline route. These species included variegated horsetail, Bicknell northern crane's-bill, yellow-seed false-pimpernel, and retrorse sedge. Variegated horsetail was found at one location west of Highway 102 around the margin of a small pond at the edge of a woods road (Figure 5.2). This population is located outside of the proposed RoW and is unlikely to be adversely affected by construction activity. This species is also present at numerous sites in ditches and embankments along Highway 102 between Truro and Miller Lake. It has also been found on a number of woods roads in the vicinity of Urbania and South Maitland. At these locations, it is typically found growing around the banks of fire ponds, in ditches and along the edges of roads where there is exposed clay mineral soil.

Bicknell northern crane's-bill was found in recent clear-cuts and on a gravel pad at the proposed underground storage facility (Figure 5.2). It was found at five locations, four of which are situated within the RoW and one at the edge of the RoW.

Retrorse sedge was found inside the proposed RoW in a young clear-cut and yellow-seed false-pimpernel was found around the margin of a large puddle in a corn field at Fort Ellis (Figure 5.2). Two other species listed as uncommon by ACCDC and considered to be secure by NSDNR were associated with salt marsh habitat along the shore of the Shubenacadie Estuary. These included tropical saltbush and bushy knotweed (Figure 5.2). Both of these species were found scattered through salt marsh habitat near the confluence of the Shubenacadie and Stewiacke Rivers. Unfortunately, the exact locations where these species were encountered were not recorded.

5.6 Wildlife and Wildlife Habitat

Birds

A list of bird species that have been recorded in the general vicinity of the proposed RoW and Shubenacadie Estuary is presented in Table I3 in Appendix I. This list is derived from the four 10 X 10 km breeding bird atlas squares within which the pipeline and Estuary are located (Erskine 1992). One hundred and twenty three species of birds were observed in these atlas squares. Not all of these species would be expected to be present in the Project area since it occupies only a small proportion of the total area of the four atlas squares and does not contain all habitat types present within the atlas squares.

Habitat modeling was used to help determine which uncommon, rare or sensitive bird species were most likely to be present in the Project area. The habitat modeling using the 100 km radius ACCDC data for birds revealed that the study area could provide suitable habitat for 23 species of uncommon or rare bird species (Table I4 in Appendix I). The modeling suggests that uncommon or rare bird species could occur at almost any location along the proposed RoW since rare and uncommon bird species characteristic of all of the habitats present along the proposed RoW have been recorded within a 100 km radius of the Project area. The number of uncommon, rare or sensitive bird species actually present along the route can be expected to be fewer than the 23 identified in the habitat modeling. Table 5.6 below lists the uncommon, rare or sensitive bird species most likely to be found along the proposed RoW or in the Shubenacadie Estuary. This list takes into consideration the best habitat fits derived from the habitat model as well as the proximity of rare bird records to the proposed Project area.

TABLE 5.6 Sensitive, Rare or Uncommon Bird Species Most Likely to be Found Along the RoW

Latin Name	Common Name	Preferred Habitat	Season	ACCDC RANK	NSDNR RANK
Chordeiles minor	Common Nighthawk	Nests in cut-overs, burns and barrens. Occasionally nests on flat roofs	Present mid-May to late September	S4	YELLOW
Chaetura pelagica	Chimney Swift	Nests in large hollow trees, chimneys and abandoned buildings	Present early May to late September	S5	YELLOW
Accipiter gentilis	Northern Goshawk	Mature coniferous and mixedwood forest	Present year round	S3	YELLOW
Hirundo rustica	Barn Swallow	Nests primarily on man-made structures such as buildings and bridges	Present mid-April to mid-November	S5	YELLOW
Contopus borealis	Olive-sided Flycatcher	Swamps and bogs with open forest cover. Burned areas and harvested areas with scattered trees. Prefers coniferous forest	Present mid-May to early September	S4S5	YELLOW
Perisoreus canadensis	Gray Jay	Coniferous forest	Present year round	S5	YELLOW
Poecile hudsonicus	Boreal Chickadee	Boreal coniferous and mixed coniferous-deciduous woodland	Present year round	S3S4	YELLOW
Sialis sialis	Eastern Bluebird	Nests in tree cavities or nest boxes. Forages in clear-cuts and orchards	Present early April to mid-October	S2S3	YELLOW
Dolichonyx oryzivorus	Bobolink	Tall grass, flooded meadows, dense grain fields	Present late April to early November	S3	YELLOW
Picoides arcticus	Black-backed Woodpecker	Coniferous forests	Present year round	S3S4	GREEN
Ammodramus nelsonii	Nelson's Sharp-tailed Sparrow	Primarily saltwater marshes but occasionally in freshwater marshes	Present late May to early November	S2S3	GREEN
Accipiter striatus	Sharp-shinned Hawk	Coniferous and mixedwood forest	Present year round but many immature birds migrate south by mid-October and return as early as early April	S3S4	GREEN

Atlantic Canada Conservation Data Centre (ACCDC) General Status Ranks	
S1	Very Rare
S2	Rare
S3	Uncommon
S4	Fairly Uncommon
SE	Exotic
Note: A combination of S ranks (*e.g.* S3S4) or the presence of a question mark denotes uncertainty regarding the population status of species	
Nova Scotia Department of Natural Resources (NSDNR) General Status Ranks	
Blue	Extinct
Red	Known to be or thought to be at risk
Yellow	Sensitive to human activities or natural events
Undetermined	Insufficient data exists to assess status
Green	Secure

Source: ACCDC 2005; NSDNR 2002; Roland and Zinck 1998

Common Nighthawk, Northern Goshawk, Chimney Swift, Olive-sided Flycatcher, Barn Swallow, Gray Jay, Boreal Chickadee, Eastern Bluebird, and Bobolink have been recorded within 10 km of the proposed RoW and suitable nesting habitat is present along the route so the potential for these species to be present is high.

Common Nighthawks nest in clear-cuts, which are a common habitat type along the proposed route. Eastern Bluebirds and Olive-sided Flycatchers will also nest in clear-cuts although they require the presence of scattered unharvested trees. Suitable habitat is present for these species; however, most of the clear-cuts contain few unharvested trees. Eastern Bluebirds used to nest in close proximity to the proposed RoW but have not been observed for a number of years (J. Veres per. comm. 2006).

Gray Jay, Black-backed Woodpecker and Boreal Chickadee nest in coniferous forest, which is present at a number of locations along the proposed RoW. The best habitats for these species are present just west of Highway 102 where conifer stands reminiscent of more northerly boreal forest are present. Black-backed Woodpeckers also nest in small islands of coniferous tree cover in clear-cuts which are present along the route.

Northern Goshawks and Sharp-shinned Hawks prefer to nest in mature softwood or mixedwood stands. Mature forest of this type is present but not widespread along the proposed RoW. This area has been subjected to heavy logging and mature stands were severely damaged by Hurricane Juan. Northern Goshawks have been reported in the area between Highway 102 and Fort Ellis but have not been observed in recent years since the extensive conifer stands that were once present in this area have been harvested over the past ten years.

Most Barn Swallows nest on anthropogenic structures such as buildings. Suitable nesting sites are scattered along much of the proposed RoW.

Bobolinks have been recorded in Admiral Rock on the side of the Shubenacadie River opposite the proposed diluted brine discharge site. Fields found along the proposed route at Fort Ellis and Alton could provide suitable habitat depending on whether or not hay is grown and the timing and frequency with which the fields are mowed.

Nelson's Sharp-tailed Sparrow has been recorded in salt marshes near the confluence of the Shubenacadie and Five-mile Rivers downstream of the proposed diluted brine discharge site. Several small salt marshes are found along the Shubenacadie River near the proposed diluted brine discharge site. These include the mouth of Rines Creek, near Admiral Rock and at Fort Ellis. These areas could be expected to support populations of Nelson's Sharp-tailed Sparrow.

Other species that warrant consideration are shorebirds, Bald Eagle and Osprey. The Shubenacadie Estuary is used as feeding habitat by migrating shorebirds. Most feeding activity occurs near the mouth of the river near Maitland where extensive sand and mud flats are present. Small numbers of migrating shorebirds (mostly Semipalmated Plovers, Semipalmated Sandpipers and Least Sandpipers) feed in the upper reaches of the river in the vicinity of Fort Ellis. The most abundant shorebird along the upper reaches of the Estuary is Spotted Sandpipers, which nest along the river.

Bald Eagles are relatively common in Nova Scotia and the Nova Scotia populations are considered to be secure; however, this species is sensitive to human activities around their nest sites. NSDNR has developed a set of guidelines regarding activities around Bald Eagle nests. There are at least four Bald

Eagle nests located on the Shubenacadie River downstream of the proposed diluted brine discharge site. The nearest nest is located approximately 1.2 km north of the proposed proposed diluted brine discharge site. The Shubenacadie Estuary attracts relatively large numbers of Bald Eagles during the winter months.

Ospreys are generally less sensitive to disturbance to human activities than Bald Eagles; however, they often nest on structures such as power poles that can bring them into conflict with human activities. NSDNR has also developed a set of guidelines regarding activities around Osprey nests.

A breeding bird survey was conducted in the study area during the period from June 27 to 29, 2006. Any rare or sensitive bird species identified as potentially present in the modeling exercise were paid particular attention to during the field surveys. Focus on the preferred habitat of rare and sensitive species was instigated to increase the efficiency of the field surveys. Birds recorded during the surveys were not limited to breeding birds only; all birds observed were identified and recorded to increase the knowledge base of avian species inhabiting or transiting the survey area.

The breeding bird survey was conducted within the footprint of the proposed Project as well as within a 400 m wide buffer zone surrounding the Project footprint (200 m on either side). The portion of the Shubenacadie Estuary near Fort Ellis was also surveyed. These areas were surveyed by an experienced birder and all birds observed or heard singing within the study area were listed and the numbers of each species in each habitat present in the study area recorded. The breeding bird survey began at 6:00 AM and was completed by 12:00 noon each survey day.

The breeding status of each species was initially determined using the criteria used in the Atlas of breeding Birds of the Maritime Provinces (Erskine 1992). Species observed or heard singing in suitable nesting habitat were classified as possible breeders. Species exhibiting the following behaviours were classed as probable breeders:

- courtship behaviour between a male and female;
- birds visiting a probable nest site;
- birds displaying agitated behaviour; and
- male and female observed together in suitable nesting habitat.

Species were confirmed as breeding if any of the following items or activities were observed:

- nest building or adults carrying nesting material;
- distraction display or injury feigning;
- recently fledged young;
- occupied nest located; and
- adult observed carrying food or fecal sac for young.

Table I5 in Appendix I presents the list of birds recorded in the Project area during the field surveys along with their breeding status and overall abundance. Table I6 in Appendix I presents the numbers of each species recorded in the various habitat types present in the Project area.

Seventy- seven species of birds were recorded during the field survey. The most abundant bird species encountered during the surveys were Savannah Sparrow, White-throated Sparrow, European Starling, Song Sparrow, American Robin, and Dark-eyed Junco. This suite of species reflects the fact that most of the proposed RoW passes through agricultural land and recent clear-cuts. The habitats along the route that contained the highest species richness were mature mixedwood forest, immature mixedwood forest, mature softwood forest, and immature softwood forest. These habitats have complex structures relative to other habitat types and are able to support a greater variety of species. The habitats that supported the highest numbers of birds were mature mixedwood forest, pasture and immature mixedwood forest. The high numbers in the two mixedwood forest habitats reflects their ability to support a wide variety of species as well as the fact that they were fairly abundant habitat types. The high number of birds associated with pasture habitat reflects the abundance of this species and the ease with which birds (particularly Savannah Sparrows) could be detected in this habitat. The habitat types intersected by the proposed RoW are indicated in Figure 5.3.

Three of the sensitive or rare bird species identified in the modeling exercise were found in the study area including Boreal Chickadee, Olive-sided Flycatcher and Barn Swallow. Boreal Chickadee was found at two locations along the proposed RoW (Figure 5.2). A Boreal Chickadee was heard calling in immature mixedwood forest habitat near the eastern end of the proposed RoW. No evidence of nesting was observed other than the presence of the species in suitable nesting habitat. Boreal Chickadees can nest in immature mixedwood forest; however, this is suboptimal habitat since this species nests in tree cavities, which are not abundant in immature stands. A Boreal Chickadee was observed in a flock of Black-capped Chickadees in August. This bird was observed in a young conifer stand on the eastern side of Highway 102. No evidence of nesting was noted during this observation. Mature conifer forest on the western side of Highway 102 would be expected to provide suitable nesting habitat for this species.

Olive-sided Flycatcher was recorded at two locations at the eastern end of the proposed RoW (Figure 5.2). One bird was heard at a long distance (200 to 300 m) to the west of the proposed pipeline RoW. It is likely that this bird was singing in a large swamp. The second bird was heard singing in a mixedwood treed swamp situated just east of the RoW. Olive-sided Flycatchers are often found in mixedwood or softwood treed swamps that support an open tree canopy and snags.

One Barn Swallow was observed at the western end of the RoW flying over pasture habitat (Figure 5.2). There were a number of houses, barns and other outbuildings in the area which would provide suitable nesting habitat for this species.

Two raptor nests were found during the field survey including a Broad-winged Hawk nest found near Alton (Figure 5.2) and an Osprey nest found near Highway 102. The Broad-winged Hawk nest was found in the crotch of a red maple approximately 4 m above the ground. The nest was found 3 m from the edge of the proposed pipeline RoW. Broad-winged Hawks rarely reuse their nests so it is unlikely that the nest found during the field survey will be used again in the future.

The Osprey nest was found on a power pole on a transmission line that was running parallel to Highway 102 (Figure 5.2). The nest was approximately 185 m from the edge of the proposed RoW and 190 m from the edge of Highway 102. The nest is visible from Highway 102. The power pole was located at the edge of a large clear-cut affording the adults a large field of view. The adult birds became agitated when the observers approached within approximately 200 m indicating that they were habituated to vehicle traffic but not to the presence of humans. Osprey can be very tolerant of humans

and will often nest in cities in high use areas such as on banks of lights at sports fields. However, Osprey nesting in more remote areas may become agitated when they detect humans at relatively long distances. Osprey will typically reuse a nest over the course of many years. NSDNR has developed guidelines for working around Osprey nest sites.

A pair of Merlins was observed near Fort Ellis on June 28, 2006 suggesting that they were a nesting pair. These birds displayed no anxiety at the presence of the observer suggesting that the nest was not nearby. One of the birds eventually flew to a small mature softwood stand in the middle of a pasture,

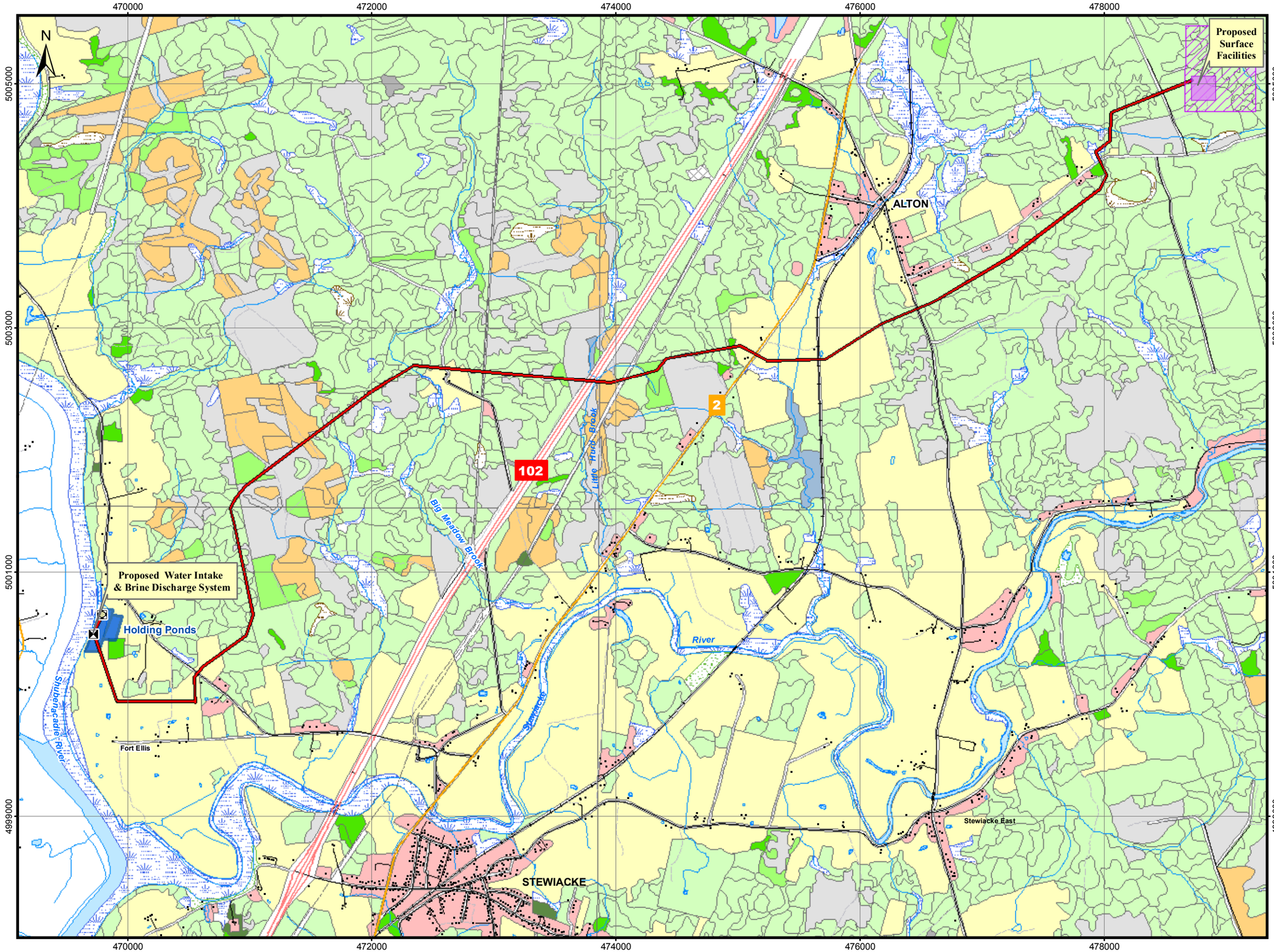

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Figure 5.3 Habitat Types Along the RoW

Map Features

- Water Intake
- Brine Discharge
- Building (1997, NSTS, 10k)
- Proposed Pipeline Route (20m ROW)
- Holding Ponds
- Proposed Surface Facilities
- Proposed Subsurface Facility
- Bridge
- Major Highway
- Collector Highway
- Paved Road
- Unpaved Road
- Rail
- Utility Line
- Watercourse

NSDNR Forest Inventory

- Wetlands
- Beaver Flowage
- Treed Bog
- Water
- Brush
- Agriculture
- Urban
- Alder Stands
- Gravel Pit
- Natural Forest Stand
- Treated Forest Stand
- Old Field
- Dead Stand
- Plantation
- Clear Cut
- Waterbody

Data Source: NSDNR

0 250 500 1,000
Metres

Map Parameters
Projection: UTM, NAD83, Zone 20
Scale 1 : 30,000
Date: June 06th, 2007
Project No.: 1012229.

Jacques Whitford

which may have been the nest site. It was not possible to investigate the possible presence of a nest at this location since the observer did not have permission to enter this property. Merlins are quite tolerant of human activities and often nest in close proximity to human habitation. A Merlin nest was recently discovered in a small forest stand located immediately adjacent to Hants East Regional High School in Milford. Merlins are listed as uncommon to fairly common in Nova Scotia (S3S4) by ACCDC and are "green" listed by NSDNR indicating that they are considered to be secure in Nova Scotia.

Other raptor species were recorded during the field surveys including Northern Harrier, Red-tailed Hawk, American Kestrel, Great Horned Owl and Barred Owl. No evidence of nesting by these species on or near the proposed RoW was recorded during the breeding bird survey. Several other raptor species have been recorded in the area in the past including Northern Goshawk, Sharp-shinned Hawk, and Northern Saw-whet Owl (J. Veres, pers. comm. 2006). Northern Goshawk, a "yellow" listed species was observed regularly in the area west of Highway 102 until recently. This area has been extensively logged over the past decade resulting in the loss of nesting habitat. Northern Goshawks have not been observed in this area in recent years

Evidence of a Great Blue Heron rookery was collected during the field survey. A local resident indicated to the biologists conducting the field survey that there was a Great Blue Heron rookery located approximately 500 m south of the proposed RoW (J. Veres, pers. comm. 2006). While the biologists spoke with Mr. Veres, four Great Blue Herons were observed flying towards the location where he had indicated that the rookery was located. A compass bearing was taken from a known point near the RoW towards the direction of flight of the Great Blue Herons; the approximate location is indicated on Figure 5.2. The size of the rookery is not known.

Mammals

Four rare or uncommon mammal species have been identified as potentially present along the proposed RoW including little brown bat (*Myotis lucifugus*), eastern pipistrelle (*Pipestrellus subfavus*), hoary bat (*Lasiurus cinereus*), and moose (*Alces alces*) (Table 5.7).

TABLE 5.7 Rare or Uncommon Terrestrial Mammal Species Potentially Found in Project Area

Latin Name	Common Name	Preferred Habitat	Likelihood on Site	ACCDC RANK	NSDNR RANK
Myotis lucifugus	Little Brown Bat	Forages in a wide variety of habitats, roosts in caves, houses and trees. Hibernate in caves or abandoned mine shafts.	Likely	S4	YELLOW
Pipestrellus subflavus	Eastern Pipistrelle	Forages along watercourses, riparian habitats and pastures. Roosts in caves, crevices, houses, or trees. Hibernates in caves.	Possible	S1?	YELLOW
Lasiurus cinereus	Hoary Bat	Forages and roosts in forests and well treed urban areas.	Possible	S2?	YELLOW
Alces alces	Moose (Mainland Population)	Forested areas containing both mature and early successional stages, typically remote from human habitation. Also frequent bogs, swamps and lake margins.	Unlikely but Possible	S1	RED (Endangered)
Likelihood on Site					
Unlikely		Very low probability due to likely absence of suitable habitat, or dispersability limitations combined with lack of nearby known populations.			
Unlikely but possible		Low probability due to likely absence of suitable habitat or dispersability limitations combined with lack of nearby known populations, but with more potential than above.			

TABLE 5.7 Rare or Uncommon Terrestrial Mammal Species Potentially Found in Project Area

Latin Name	Common Name	Preferred Habitat	Likelihood on Site	ACCDC RANK	NSDNR RANK
Possible		Medium probability due to more proximal known populations, better dispersability and greater chance apparent existing habitats could hold these species.			
Likely		High probability of encountering these species in habitats possibly present in the study area.			
Atlantic Canada Conservation Data Centre (ACCDC) General Status Ranks					
S1		Very Rare			
S2		Rare			
S3		Uncommon			
S4		Fairly Common			
SE		Exotic			
Note: A combination of S ranks (*e.g.* S3S4) or the presence of a question mark denotes uncertainty regarding the population status of species					
Nova Scotia Department of Natural Resource (NSDNR) General Status Ranks					
Blue		Extinct			
Red		Known to be or thought to be at risk			
Yellow		Sensitive to human activities or natural events			
Undetermined		Insufficient data exists to assess status			
Green		Secure			

Source: ACCDC 2005; NSDNR 2002; Roland and Zinck 1998

Of these species, little brown bat is the species most likely to occur along the RoW. This species is relatively common and is widely distributed in many habitat types during late spring, summer and early autumn. Although it is a common species, the little brown bat is listed as a "yellow" species by NSDNR indicating that it is sensitive to human activities or natural events. This is attributable to the fact that large concentrations of little brown bats occur at suitable hibernation sites such as caves and abandoned mine shafts. This species is sensitive to disturbance during the hibernation period and repeated disturbances may cause bats to expend all of their fat reserves resulting in increased mortality caused by starvation. As such, disturbance events during the hibernation period have the potential to adversely affect large numbers of bats. The largest known bat hibernaculum in Nova Scotia is located at Hayes Cave approximately 11 km northwest of the proposed RoW. Much of the terrain that the RoW traverses is underlain by gypsum and limestone in which solution caves can develop. The presence of solution caves is usually indicated by the presence of karst topography which consists of a patterns of sink holes and gypsum outcropping. No karst topograpgy was noted during the field survey suggesting that it is unlikely that bat hibernacula are present along the RoW.

The eastern pipistrelle is much rarer than the little brown bat and it too has been recorded at Hayes Cave. Eastern pipistrelles are less sensitive to disturbance around the hibernaculum sites than little brown bats since they are not easily roused from hibernation. However, they are equally sensitive to direct loss of hibernation habitat.

Hoary bats do not hibernate but migrate south in the autumn. Unlike little brown bats and eastern pipistrelles, hoary bats are most sensitive during the summer months, particularly during the period when young bats are too heavy for their mothers to carry with them and are unable to fly. Little is known about the distribution or abundance of hoary bats in Nova Scotia since they are nocturnal forest dwellers and do not congregate in large numbers. This species is probably widely dispersed across the landscape at low population densities.

The mainland moose population is listed as an endangered population under the Nova Scotia *Endangered Species Act*. The cause of the decline of this population is poorly understood and may be attributable to a variety of factors. Conversely, the Cape Breton moose population (a distinct population composed of animals introduced from Alberta) is doing well and supports a limited sport hunt and

aboriginal subsistence hunting. Suitable habitat is present along the proposed route but there is little moose activity in this area. Moose are regularly encountered in the Cobequid Mountains approximately 40 km north of the proposed RoW.

Information regarding the presence of mammals along the proposed RoW and in the Shubenacadie Estuary was derived from field observations made during the breeding bird survey and vegetation surveys as well as through interviews with residents. One of the biologists conducting the field surveys has lived in the area for 18 years and has firsthand knowledge of the fauna of the area.

Table 5.8 lists the mammals that have been recorded in the Project area. Three rare or sensitive mammal species have been reported from the area including moose, harbour porpoise and little brown bat.

TABLE 5.8 Mammal Species Recorded during Field Surveys of the Project Area

Common Name	Binomial	Habitat	NSDNR Ranking	ACCDC Ranking
Shrew, short tail	*Blarina brevicauda*	Hardwood forest, high humidity and loose humus	N/A	S5
Whitetail Deer	*Odolcoileus virginianus*	Edges of hardwood forest, glades, swamp edges, stream banks, cedar swamps	Green	S5
Moose (Mainland Population)	*Alces alces americana*	Shrubby growth and late aspen-birch parkland	Red (Endangered)	S1
Long-finned Pilot Whale (Bay of Fundy population)	*Globicephala melaena*	Cold temperate waters both pelagic and offshore	-	S2S3
Harbour Porpoise (Bay of Fundy population)	*Phocoena phocoena*	Inshore waterssuch as bays, channels and harbours	-	S4
Mink	*Mustela vison*	Small streams, marshes, lake edges and seashores	Green	S5
River Otter	*Lutra canadensis*	Lakes, marshes, streams and seashores	Green	S5
Coyote	*Canis latrans*	Hilly country with poplar bluffs, willow-lined stream banks, boreal forest, aspen parklands, short-grass steppes	Green	S5
Red Fox	*Vulpes vulpes*	Agricultural areas, lakeshores, river valleys, natural clearings	Green	S5
Bobcat	*Lynx rufus*	Forest areas as well as barrens and bogs	Green	S5
American Black Bear	*Ursus americanus*	Coniferous or deciduous regions, swamps, berry patches	Green	S5
Racoon	*Procyon lotor*	Forested areas near watercourses, river valleys, trees in grasslands	Green	S5
Harbour Seal	*Phoca vitulina*	Coastal waters including bays, harbours and coastal rivers. Occassionally ventures into fresh water	-	-
Red-backed Vole	*Clethrionomys gapperi*	Mature and second growth forest, barrens, bogs, stream and lake shores	Green	S5
Meadow Vole	*Microtus pennsylvanicus*	Grasslands including hay fields, old fields, pastures, floodplain meadows, bogs, barrens, salt marshes, shrub thickets with grassy understory and forest with grassy understory	Green	S5
Deer Mouse	*Peromyscus maniculatus*	Mature and second growth forest, barrens, bogs, clear-cuts, old fields, and shorelines	Green	S3/S4
Beaver	*Castor canadensis*	Slow-flowing streams, lakes, rivers, and marshes	Green	S5
Porcupine	*Erethizon dorsatum*	Deciduous and coniferous regions, farmland	Green	S5
Eastern Chipmunk	*Tamias striatus*	Dry hardwood forest, hedgerows, fences, stone piles, gardens	Green	S5
Red Squirrel	*Tamiasciurus hudsonicus*	Boreal coniferous forest, eastern hardwood deciduous forest, mixed forests	Green	S5
Varying Hare	*Lepus americanus*	Forests, swamps, riverside thickets	Green	S5

Moose sightings have been made in the general vicinity. A local resident reported that moose are detected in the area once every few years (J. Veres pers. comm. 2006). No tracks or feces of moose were observed during any of the field surveys. It appears that moose occasionally wander into the area. The area contains large numbers of white-tailed deer, which would result in a high potential for infection of moose with brain worm (*Parelaphostrongylus tenuis*) which is believed to be one of the factors that has resulted in the decline of the mainland moose population in Nova Scotia.

Harbour porpoise have been recorded in the Shubenacadie Estuary. Approximately ten years ago a stranded harbour porpoise was rescued from the mouth of Five Mile River, tributary of the Shubenacadie River approximately 12 km north of Fort Ellis. Harbour porpoises are listed as Special Concern under the federal *Species at Risk Act* (*SARA*). Harbour porpoises are frequently encountered in the open Bay of Fundy but rarely enter the Shubenacadie Estuary.

Little brown bats are observed in the general vicinity of the proposed pipeline RoW during the summer months. At this time of year, this species is not particularly vulnerable. Small colonies of female bats and their young may be present but given the lack of karst topography or abandoned mines along the route, it is unlikely that any large winter hibernacula sites are present. Most of the natal colonies would be located in the attics of buildings.

John Veres (pers. comm. 2006) reports that eastern cougar has been sighted in the Green Oaks area approximately 10 km north of the Project area. Although there have been a large number of sightings of this species, its presence in Nova Scotia has not been verified.

A review of the NSDNR sensitive habitat mapping database did not reveal the presence of other sensitive mammal habitats such as deer wintering areas.

Herpetiles

Two uncommon or sensitive herpetile species, four-toed salamander (*Hemidactylium scutatum*) and wood turtle (*Glyptemys insculpta*) are potentially present along the proposed RoW (Table 5.9).

TABLE 5.9 Rare or Uncommon Herpetile Species Potentially Found in Project Area

Latin Name	Common Name	Preferred Habitat	Likelihood on Site	*SARA*	ACCDC RANK	NSDNR RANK
Hemidactylium scutatum	Four-toed Salamander	Breeds in small pools or sluggish streams fringed by sphagnum moss in bogs and swamps. Adults live in surrounding woodlands.	Likely		S3	YELLOW
Glyptemys insculpta	Wood Turtle	Slow moving meandering streams through fertile valleys. Nest in sand or gravel beaches or occasionally sand pits. Forage in riparian habitats.	Possible	Special concern	S3	YELLOW (Vulnerable)
Likelihood on Site						
Unlikely		Very low probability due to likely absence of suitable habitat, or dispersability limitations combined with lack of nearby known populations.				
Unlikely but possible		Low probability due to likely absence of suitable habitat or dispersability limitations combined with lack of nearby known populations, but with more potential than above.				
Possible		Medium probability due to more proximal known populations, better dispersability and greater chance apparent existing habitats could hold these species.				
Likely		High probability of encountering these species in habitats possibly present in the study area.				
SARA						
Extirpated		A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild				
Endangered		A wildlife species that is facing imminent extirpation or extinction				

TABLE 5.9 Rare or Uncommon Herpetile Species Potentially Found in Project Area

Latin Name	Common Name	Preferred Habitat	Likelihood on Site	*SARA*	ACCDC RANK	NSDNR RANK
Threatened		A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction				
Special concern		A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats				
Atlantic Canada Conservation Data Centre (ACCDC) General Status Ranks						
S1		Very Rare				
S2		Rare				
S3		Uncommon				
S4		Fairly Common				
SE		Exotic				
Note: A combination of S ranks (*e.g.* S3S4) or the presence of a question mark denotes uncertainty regarding the population status of species						
Nova Scotia Department of Natural Resource (NSDNR) General Status Ranks						
Blue		Extinct				
Red		Known to be or thought to be at risk				
Yellow		Sensitive to human activities or natural events				
Undetermined		Insufficient data exists to assess status				
Green		Secure				

Source: ACCDC 2005; NSDNR 2002; Roland and Zinck 1998

Four-toed salamanders are listed by ACCDC as uncommon and are "yellow" listed by NSDNR indicating that they are sensitive to human activities or natural events. It is highly likely that this species is present in some of the swamp and bog habitats near the proposed pipeline. A recent study (JWEL 2000) demonstrated that four-toed salamanders are more abundant and widespread than earlier records would indicate. This study also showed that they were able to use a variety of anthropogenic habitats as nesting habitat including wheel ruts, ditches and ponds. It is likely that the population status of this species will soon be changed to secure.

Wood turtles are found along both the Shubenacadie and Stewiacke Rivers and their tributaries. This species is found in riparian habitats and only rarely ventures into tidal areas. The tributaries of the Stewiacke River crossed by the proposed RoW, particularly the slower streams with fertile riparian zones (Little Hurd Brook and Big Meadow Brook) have the most suitable habitat for this species. Although this species is uncommon rather than rare, it is listed as vulnerable under the Nova Scotia *Endangered Species Act* and of special concern under the federal *Species at Risk Act*. This designation is attributable to the fact that this species is declining in Nova Scotia and is susceptible to even small increases in mortality. Alteration of riparian habitat and translocation of wood turtles to unsuitable habitats have contributed to the decline of this species.

Information regarding the presence of herpetiles along the proposed RoW was collected in conjunction with the vegetation and breeding bird surveys. Herpetiles were detected by passive observation and listening as well as through limited directed searching, which typically involved searching under cover items such as rocks and logs and the netting of amphibian larvae in surface waters. Some directed searching of potential four-toed salamander habitat was also conducted along and adjacent to the proposed pipeline RoW. Additional information on local amphibian and reptile species was gathered through an interview with John Veres, a local resident familiar with the wildlife in the Project area.

Six species of amphibians were noted during the field surveys including spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*), red back salamander (*Plethodon cinereus*), northern spring peeper (*Pseudacris crucifer crucifer*), wood frog (*Rana sylvatica*), and northern green frog (Rana *clamitans melanota*). All of these species are common and widespread

in the Province. Two reptile species were noted and three more species were reliably reported by a local resident (J. Veres pers. comm. 2006). The species directly encountered are the maritime garter snake (*Thamnophis sirtalis pallidula)*, and eastern painted turtle (*Chrysemys picta).* Other reptile species reported from the area include northern redbelly snakes (*Storereia occipitomaculata occipitomaculata*), and smooth green snakes (*Lilochlorophis vernalis*) (J. Veres pers. comm. 2006). Mr. Veres also reported the presence of Wood Turtles (*Glyptemys insculpta*) from Big Meadow Brook.

With the exception of northern ribbon snake (*Thamnophis sauritus septentrionalis*) and Blanding's turtle (*Emydoidea blandingi*) which do not have populations in this region, most of the reptiles and amphibians should be present along the proposed pipeline RoW. Possible exceptions would be species characteristic of lakes and large ponds and slow stretches of river such as mink frog (*Rana septentrionalis*), bull frog (*Rana catesbeiana*), and common snapping turtle (*Chelydra serpentina*).

During the June survey period, an effort was made to locate nesting four-toed salamanders in the few apparently suitable areas of ditch or wetland habitat found in or adjacent to the proposed RoW. No four-toed salamanders were recorded; however, given the cryptic nature of this salamander and its nest sites, it is quite possible that local populations were present but were missed. Recent surveys have shown this species to be more widely distributed and abundant in the province than previously thought. Four-toed salamanders are also capable of breeding in a variety of wetland habitats including some of anthropogenic origin or modification. Given this and the fact that the proposed pipeline RoW will avoid wetland habitat (by means of route modifications or HDD under wetland habitat) no significant impacts on four-toed salamanders are expected.

Wood turtles were not encountered during the field surveys; however, Mr. Veres provided a credible report of seeing this species along Big Meadow Brook near the proposed pipeline crossing area. It is possible that wood turtles may also frequent the section of Hurd Brook crossed by the pipeline. At both of these locations, the brook depths are not ideal for wood turtle hibernacula. At Big Meadow Brook, there are no proximal areas highly suitable as wood turtle nest sites. Along Hurd Brook, the nearby cleared highway RoW and shoulder are marginal as nesting sites in part due to the narrow brook and riparian section not being prime wood turtle habitat and due to the attendant perils of proximity to the highway. Neither location comprise core habitat for wood turtles. Furthermore, the proposed directional drilling of such watercrossings would minimize any negative effects to habitat integrity.

5.7 Land and Resource Use

5.7.1 Residential, Industrial, and Commercial Land Use

The Project is located entirely within the Municipality of the County of Colchester. There are two incorporated towns located in the County: Truro (population 11,457) and Stewiacke (population 1,388) (Statistics Canada 2002). The proposed underground storage location is near the community of Alton, with the water pipelines travelling through Fort Ellis. Nearby communities include Stewiacke, Riverside, Brookfield and Stewiacke East (Figure 1.2).

The majority of land use in the study area is residential, agricultural and forestry-related (Figure 5.3). The proposed RoW intersects 37 properties, of which 10 contain residential structures. There are approximately 6 residences located within 100 m of the Project and 83 residences within 500 m of the

Project. The distance to the closest residence is approximately 52 m. There is currently no land use zoning or development plan in place that applies to the Project site or adjacent lands.

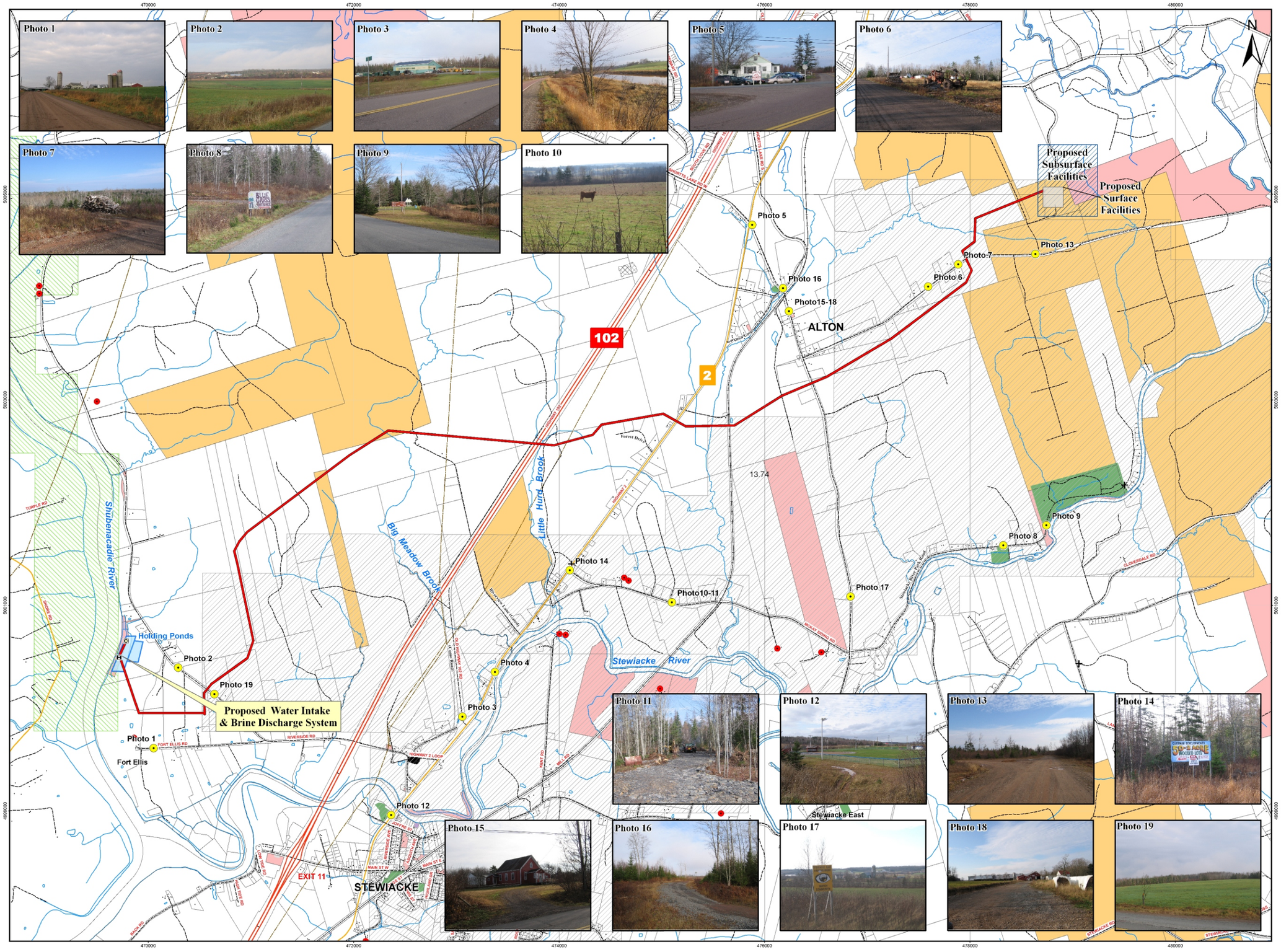
The largest residential population centres near the proposed Project are the Town of Stewiacke located less than 1 km from the RoW and the Town of Truro located 20 km from the Project.

Table 5.10 provides statistics on the population and dwelling counts of the study area (Colchester Subdivision C) compared to the nearest town (Stewiacke), the overall county and the province. These statistics help to demonstrate the rural nature of the study area, given the low population density relative to Stewiacke, Colchester County and the province.

TABLE 5.10 Population and Dwelling Counts

	Colchester Subdivision C	Stewiacke	Colchester County	Nova Scotia
Population in 2001	13,391	1,388	49,307	908,007
Total Private Dwellings	5,552	565	22,086	403,819
Population Density (individuals per sq km)	9.3	78.6	13.6	17.2
Land Area (sq km)	1,443	17.67	3,627	52,917

Source: Statistics Canada 2002



alton
NATURAL GAS STORAGE LP

Alton Gas Storage Project

Figure 5.4 Socio Economic Features

- Photo Locations
- Water Intake
- Brine Discharge
- Building (1997, NSTS, 10k)
- Gate
- Silo
- Proposed Pipeline Route (20m ROW)
- Holding Ponds
- Proposed Surface Facilities
- Proposed Subsurface Facilities
- Major Highway
- Collector Highway
- Unpaved Road
- Rail
- Utility Line
- Watercourse
- Waterbody
- Mineral Exploration (Pending Renewal)
- Mineral Right: Salt & Potash (Issued)
- Property Boundary

Designated Area

- Recreation Facility/Field
- Cemetery
- Parking Area
- Pit
- Sewage Treatment Plant
- Crown Land
- Neenah Paper Property

PHOTO LEGEND
Photo 1 - Farm at End of Fort Ellis Road
Photo 2 - Shubenacadie River
Photo 3 - Logan Drilling on Commo Road
Photo 4 - Stewiacke River Along Highway 2
Photo 5 - Auto Dealer (Shortts Lake Rd & Highway 2)
Photo 6 - Logging Equipment
Photo 7 - Woodlot on Stevens Road
Photo 8 - Ethagram Festival Location
Photo 9 - Stewiacke River Park
Photo 10 - Agriculture Lands on McKay Siding Road
Photo 11 - Operational woodlot (McKay Siding Road)
Photo 12 - Ballfield
Photo 13 - Intersection of Logging Roads with Stevens Road
Photo 14 - Real Estate Sign on Corner of McKay Siding Road
Photo 15 - Community Centre
Photo 16 - End of Forest Drive Looking Into Woodlot
Photo 17 - Stewiacke East
Photo 18 - Vermeulan Farms
Photo 19 - Camelot (479 Riverside)

0 250 500 1,000
Metres

Map Parameters
Projection: UTM, NAD83, Zone 20
Scale 1 : 30,000
Date: June 05th, 2007
Project No.: 1012229

Jacques Whitford

Commercial land uses in the immediate study area are predominantly home-based service industries (*e.g.,* construction contracting, limousine service, auto repair, electronic and motor repairs, *etc*.). The Town of Stewiacke is the closest commercial centre with various food and retail outlets, financial institutions and business services.

Industries operating in the immediate Project area include Logan Drilling Limited and National Truss Span, both located on Commo Road in Stewiacke. Other industries located within the core of the Town of Stewiacke include a pallet manufacturer and a window manufacturer.

5.7.2 Agriculture and Natural Resource Use

As shown on Figure 5.3, there are mineral exploration licenses (salt and potash) issued in the study area. Landis Energy and its partner, Fort Chicago Energy Partners L.P. hold several Special Explorations Licenses, granted by the Nova Scotia Government, over the Alton area. These licenses provide exclusive rights to any salt or potash within the license area and are the first steps required by Nova Scotia Government regulations prior to moving the Project forward to a Hydrocarbon Storage License. There are no mineral claims along the RoW (R. Ratcliffe, NSDNR, pers. comm., 2007).

Based on aerial photography, it is estimated that the proposed RoW crosses 27 parcels of forested land. One parcel is crown land and four parcels are owned by Neenah Paper Company of Canada (spun off from Kimberly-Clark Corporation in 2004). In Nova Scotia, Neenah Paper operates a kraft pulp mill in Pictou along with several hectares of timberlands.

In 2005, Colchester County produced a total of 934,990 m^3 of wood products. Of this, 88% were softwood products and 12% were hardwood products (Table 5.11). Also in 2005, there were 24 sawmills operating in the County, with the closest to the study area being a small sawmill located in Brookfield.

TABLE 5.11 Volume of Colchester County Wood Products by Owner Class, 2005

	Softwood (m^3 solid)	Hardwood (m^3 solid)	Total (m^3 solid)
Crown Land	46,966	8,718	55,684
Industrial	290,980	61,126	352,106
Private	476,197	46,573	522,770
Federal	4,430	0	4,430
All Owners	818,573	116,417	934,990

Source: NSDNR 2006

There are approximately 452 farms in Colchester County, representing about 11.5% of the provincial total (CoRDA undated). A wide variety of crops are grown but the major proportion of cropland is devoted to forage crops, dairy cattle and beef production.

Based on air photography, the proposed RoW crosses approximately 18 agricultural properties. The majority of these fields are cultivated to forage crops or pasture land. Forage crops may include alfalfa, grass alfalfa, clover, forage corn, and occasional small grains (wheat, oats, and barley). The majority of the RoW is underlain by Queens soils which are imperfectly drained to poorly drained soils, and that are used predominantly for pasture and forage production. These soils are highly productive when soil

water is properly managed. Other soil associations in the area include Pugwash, Stewiacke and Acadia soils, all of which are imperfectly to poorly drained but can be productive with proper soil drainage.

5.7.3 Tourism and Recreation

Recreational land use in the study area includes the Stewiacke River Park, a small picnic park on the Stewiacke River, off the Stewiacke River Park Road. The park offers covered picnic tables, cook shelters, a playground and river access. The park is a popular spot for launching canoes or kayaks and also contains a 1-km walking trail. In close proximity to the Park, there is a private property which hosts an annual country/bluegrass music festival, usually in the month of June.

Additional recreational facilities include softball fields in Stewiacke and local community centres in Stewiacke and Alton. A windshield survey of the area revealed a small ballfield in Alton although it is unclear as to whether this is still in use.

Informal recreational land use in the study area includes hunting, ATV use and snowmobile use. Hunting is licensed through the provincial government and seasons generally run through the fall months. Although there are no formal ATV/snowmobile trails in the area, recreational use of these vehicles is quite common and the Snowmobilers Association of Nova Scotia has expressed interest in developing trails to other systems in the province (J. Wolverton, SANS, pers. comm. 2006).

The Stewiacke and Shubenacadie Rivers are both used for recreational boating and fishing (refer to Sections 5.9 and 6.6 for more information on existing conditions and impact analysis for fishing activities). There are two river rafting companies which operate on the Shubenacadie River and feature tidal bore rafting. Both tour operators launch several kilometres downstream of the proposed discharge system and would not interact with the Project (B. van deVries, Shubenacadie River Runners, pers. comm. 2007).

Immediately adjacent to Highway 102 at Exit 11 is the Mastodon Ridge attraction which prominently displays a replica of a mastodon whose bones were unearthed at a gypsum quarry 15 km from the site, in Milford. Around this theme, the attraction includes a garden, theatre and exhibits which showcase Stewiacke from the Ice Age to modern times. This site also celebrates being the halfway point between the North Pole and the equator. In addition, this attraction includes a gift shop, walking trail and mini-golf. There is also a gas station and several fast food restaurants at this location. Across the highway at this exit there is a large garden centre. As a result of these facilities and attractions, Exit 11 is a popular stopping spot for travelers on Highway 102.

Further removed from the study area, but relevant to tourism associated with the Stewiacke area, is the Shubenacadie Provincial Wildlife Park located between Shubenacadie and Stewiacke on Highway No. 2. This 40 ha park is owned and operated by NSDNR and contains wildlife exhibits of native and exotic species of mammals and birds. Adjacent to the wildlife park is a large picnic and playground area.

5.8 Labour and Economy

In 2005, Nova Scotia's gross domestic product (GDP) was estimated to be approximately 31.3 billion dollars with 77% of the GDP coming from service producing industries (*e.g.,* finance, insurance, real estate, business services, *etc*.) (Nova Scotia Department of Finance 2005, Statistics Canada 2006). In

2005, leading exports by commodity included: non-metallic minerals (*e.g.*, gypsum) and mineral fuels (coal) (27%), fishery products (18%), and forestry products (*e.g.,* paper, lumber, pulp) (17%).

In 2001, Nova Scotians recorded a median household income of $39,908, labour force participation rate (*i.e.,* the percentage of eligible population who are active in the labour market) of 61.6% and an unemployment rate of 10.9% (Table 5.12). The median age of the population in 2001 was 38.8 years.

Colchester County has a population of 49,307 and covers a land area of 3,628 km^2, with a population density of 13.6 per square kilometre. This is less than the provincial density average of 17.2 for Nova Scotia. A large number of the county's population lives in rural areas with only 26% of the population living in the two towns in the county (Truro, population 11,457, and Stewiacke, population 1,388) (Statistics Canada 2002).

Table 5.12 provides a summary of select labour force characteristics based on census data from 2001. The Project area (*e.g.,* Alton, Fort Ellis, Riverside) falls under the federal census classification of Colchester Subdivision C, which is a rural area that covers a land area of 1,443.06 km^2. However, due to its proximity, statistics for the Town of Stewiacke are also provided for reference to help characterize the overall study area (Table 5.12). Statistics for Colchester County are inclusive of the Subdivision C and Stewiacke statistics.

TABLE 5.12 Summary of Selected Demographic, Income and Labour Characteristics, 2001

	Colchester Subdivision C	Stewiacke	Colchester County	Nova Scotia
Population in 2001	13,391	1,388	49,307	908,007
Population Change (% change 1996 to 2001)	3.0	-1.2	0.1	-0.1
Median age of the population (years)	38.3	37.9	39.3	38.8
Median household income	$42,650	$40,466	$37,068	$39,908
Labour force participation rate	67.0	55.7	62.7	61.6
Unemployment rate	9.6	12.3	9.9	10.9
Employment rate	60.5	48.4	56.5	54.9

Source: Statistics Canada 2002
Note: 2006 data were not available for all census areas.

Of particular note is the 3% population increase in Colchester Subdivision C and 1.2% population decrease in the Town of Stewiacke, relative to the 0.1% population decrease for Nova Scotia. The Project area also has a slightly higher median income and higher employment rate compared to the Province as a whole.

Table 5.13 summarizes labour force by industry, showing a clear distinction between the rural division of Colchester County versus the Town of Stewiacke. Manufacturing and construction industry makes up 21.9% of the labour force for Colchester Subdivision C but only 10.7% of the labour force in Stewiacke. The leading industry for the Town of Stewiacke in terms of total labour force is business services (27.3% versus 13.9% for Colchester Subdivision C).

TABLE 5.13 Summary of Labour Force by Industry, 2001

	Colchester Subdivision C	Stewiacke	Colchester County	Nova Scotia
Total Experienced Labour Force	6,995	605	24,380	442,425
Agriculture and other resource-based industry (% of total labour force)	660 (9.4%)	45 (7.4%)	1,780 (7.3%)	29,000 (6.5%)

TABLE 5.13 Summary of Labour Force by Industry, 2001

	Colchester Subdivision C	Stewiacke	Colchester County	Nova Scotia
Manufacturing and construction industries (% of total labour force)	1,535 (21.9%)	65 (10.7%)	4,990 (20.5%)	70,955 (16.0%)
Wholesale and retail trade (% of total labour force)	1,285 (18.4%)	135 (22.3%)	4,580 (18.9%)	71,085 (16.1%)
Finance and Real Estate (% of total labour force)	115 (1.6%)	10 (1.7%)	690 (2.8%)	20,620 (4.7%)
Health and Education (% of total labour force)	1,035 (14.8%)	65 (10.7%)	4,045 (16.6%)	80,700 (18.2%)
Business Services (% of total labour force)	970 (13.9%)	165 (27.3%)	3,300 (13.5%)	70,270 (15.9%)
Other Services (% of total labour force)	1,400 (20.0%)	120 (19.8%)	4,995 (20.5%)	99,790 (22.6%)

Source: Statistics Canada 2002
Note: 2006 data were not available for all census areas.

In line with their mandate to drive sustainable economic growth, the Colchester Regional Development Agency (CoRDA) has prepared a Regional Economic Plan for Colchester (Growing Colchester 2005-2010). Their economic model focuses on the following objectives: supporting existing businesses to survive and grow; attracting new enterprise to Colchester; creating new enterprise through innovation and entrepreneurial activity; and creating a vibrant and welcoming community in which to live and work (CoRDA undated).

In an unrelated, but compatible initiative, CoRDA and the Town of Stewiacke have proceeded with a concept development plan for the Stewiacke Business Park. In 2005, they commissioned a study to facilitate the marketing of Town-owned lands near Exit 11 on Highway 102. With its location on the Halifax-Moncton Growth Corridor, proximity to Truro, proximity to the rapidly developing Municipality of East Hants, and exposure on a heavily travelled route through central Nova Scotia, Exit 11 could be an advantageous location to justify building new business infrastructure in the area (EDM 2005).

The proposed site for the Stewiacke Business Park comprises two properties that together cover approximately 30 ha of land south of Exit 11 from Highway 102 near the western boundary of the Town. The main obstacle to further development of this plan is the lack of road access to the business park land and the need to negotiate an access with abutting landowners who have either access to Main Street West or Highway 2 (EDM 2005, S. Dorey, Town of Stewiacke, pers. comm., 2006). It is predicted that the Town would benefit from the development of the park through the sale of land and ongoing property tax revenues, and the community would benefit from increased employment opportunities as a result of businesses attracted to the area (EDM 2005).

5.9 Fisheries Resources

The Shubenacadie and Stewiacke Rivers and their many tributaries form a large, dynamic watershed of ecologic, historic and economic significance. The fish community in the Shubenacadie watershed is diverse, with a variety of diadromous and freshwater species. In addition, the fish community is enriched by a number of marine and euryhaline fish species. Fish species and their life history characteristics are described in detail in Section 5.4.

A number of fish populations in the watershed have been and continue to be exploited by commercial and recreational fishers. Gaspereau and American shad are the main commercial species fished in the

Estuary. Fishers near the Project use gillnets and small vessels to fish for these species in the spring. Licensing, gear restrictions and quotas are controlled by DFO. In the past, Atlantic salmon, striped bass and Atlantic sturgeon were targeted by commercial fishers in the Estuary; however, these species are now caught only as bycatch. Weir and dipnet fisheries for gaspereau occur further upstream in freshwater reaches of the Stewiacke and Shubenacadie Rivers, outside of the Project area.

A variety of fish species are sought after by recreational fishers in the Shubenacadie watershed, including brook trout, American shad, rainbow smelts and a number of other species. Recreational fishing activity is concentrated in freshwater reaches of the rivers, although some recreational fishing occurs in the Estuary, particularly for striped bass. Recreational fishing, likely for brook trout, may occur in some of the watercourses crossed by the proposed pipeline route.

5.10 Traditional Land and Resource Use

The Confederacy of Mainland Mi'kmaq (CMM) is a tribal council located in Millbrook, Nova Scotia that provides programs and services to Mi'kmaq communities in the province. CMM's membership consists of six Mi'kmaq communities located on mainland Nova Scotia, including Annapolis Valley First Nation, Bear River First Nation, Glooscap First Nation, Millbrook First Nation, Paq'tnkek First Nation, and Pictou Landing First Nation. The six chiefs along with Donald M. Julien, Executive Director, form the CMM board of directors who hold monthly meetings to provide direction and discuss potential issues/concerns. The Union of Nova Scotia Indians (UNSI) is the other First Nations tribal organization in Nova Scotia. UNSI has been in existence since 1969, and represents seven Mi'kmaq communities in Nova Scotia. These include Acadia First Nation, Chapel Island First Nation, Eskasoni First Nation, Membertou First Nation, Shubenacadie First Nation, Wagmatcook First Nation, and We'koqma'q First Nation. UNSI provides a unified political voice for its membership and promotes the welfare and well being of Mi'kmaq people.

There is a third organization in Nova Scotia, the Native Council of Nova Scotia (NCNS), which represents the community of Mi'kmaq and Aboriginal peoples living off-reserve in Nova Scotia throughout traditional Mi'kmaq territory.

Presently, there are two established Mi'kmaq reserves located within 15 kilometres of the Project area. The first community is the Indian Brook First Nation (also referred to as the Shubenacadie First Nation), and it is located nine kilometres from the water intake site located on the Shubenacadie River. It is located southwest of the Project area, west of the town of Shubenacadie and the Shubenacadie River. The other community is the Millbrook First Nation, and it is located approximately 14 kilometres from the proposed salt cavern storage site. It is northeast of the Project area, near the town of Truro. Today, the Millbrook First Nation has a population of 729 people and occupies about approximately 300 hectares while the Indian Brook First Nation occupies 1,234 ha and has a total population of 2,120 people. The Mi'kmaq people of both these communities have a history of continuous occupation in this area that spans centuries and begins hundreds of years before European contact.

The Shubenacadie area has historically been a key Mi'kmaq territory for the Mi'kmaq people, and the Shubenacadie Mi'kmaq community provided important resources to other Mi'kmaq peoples from the time period of first contact to colonization. During the 18th Century, and likely long before that, Mi'kmaq of the Atlantic provinces utilized the Shubenacadie River as a primary travel route, and convened in this area for political, social, and spiritual gatherings. The Mi'kmaq hunted and fished on these lands and

waters as they traveled from one community to the next. It was during these travels that the Mi'kmaq established small hunting sites, a practice that continued well into the 20th Century. Details describing historic and current use of the area are outlined in the Mi'kmaq Ecological Knowledge Study (MEKS) (Appendix J).

5.11 Archaeological and Heritage Resources

The proposed Project area traverses a range of environments and landforms. Distinct ecological zones have different heritage site types and densities, depending on their ability to contribute to or support human land use.

In order to assess existing conditions of the Project area, a Phase 1 archaeological impact assessment was conducted. The assessment included historical background research to identify areas with high potential for containing archaeological resources and a pedestrian survey, conducted on July 10, 11, 13, 14, and 15 2006, to examine those areas. Details are included in the archaeological report (Appendix K).

The background research consisted of examining the files of the Nova Scotia Museum's archaeological sites database, which contains all of the archaeological sites reported within the province. The background research found evidence of a strong Mi'kmaq presence in and around the study area due to its location near two major transportation routes, one to the coast and one to the interior. The sandbars created by the confluence of the Shubenacadie and Stewiacke Rivers also formed a natural ford that allowed easy pedestrian access from one side of the Stewiacke River to the other.

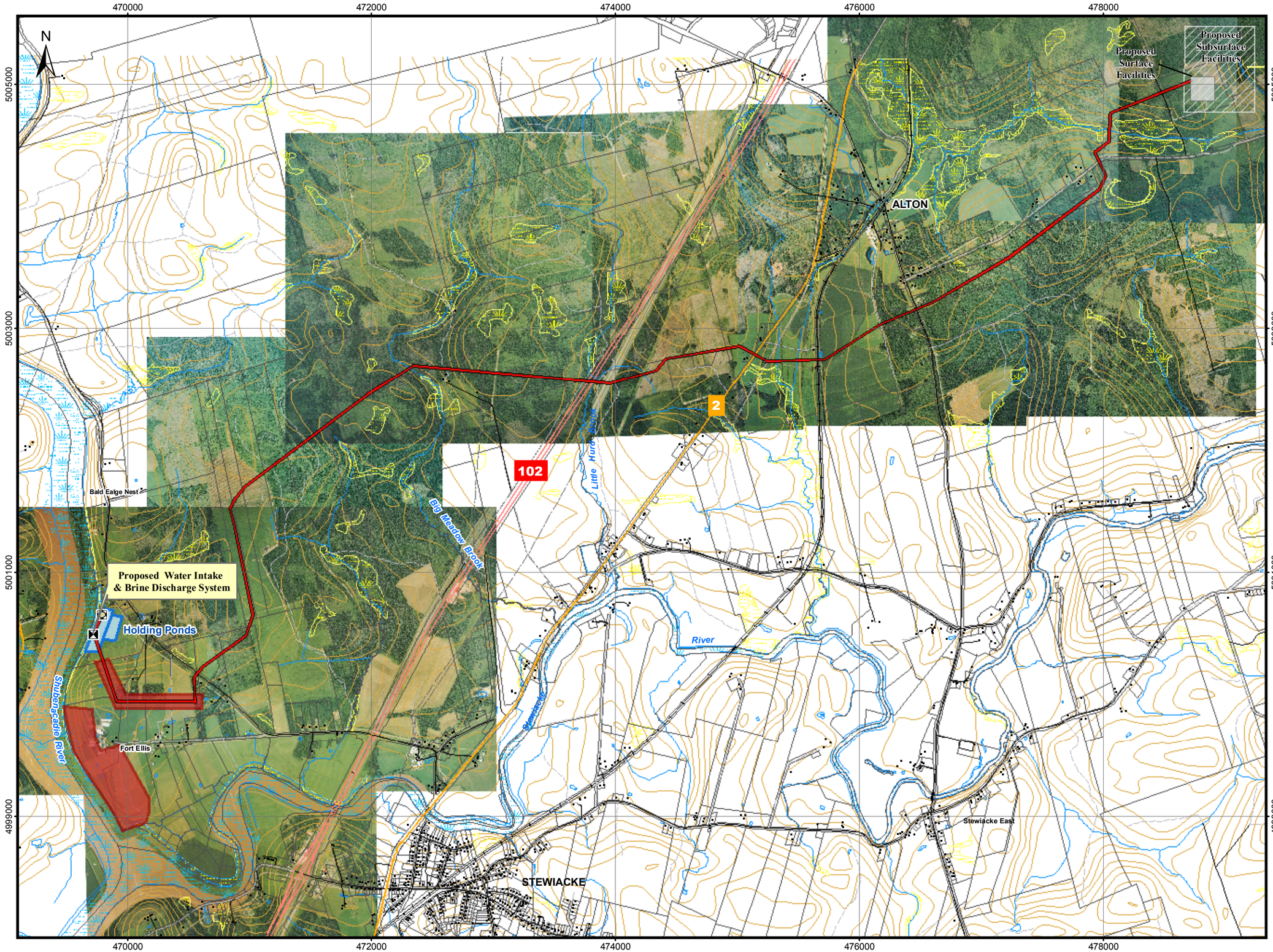
Research also shows that despite there being no recorded First Nations archaeological sites within the immediate Project area, lack of professional research in this area is the likely cause. The reported sites that lie adjacent to the Project area clearly show a settlement pattern along the high ground of the riverbanks, usually within 400 meters or so of the River. There is every reason to believe that the same criteria would apply to the study area, despite no previous reports of Mi'kmaq material being found. With this in mind, the only First Nations high potential areas identified were along the ridges where they are intersected by the intake and brine discharge system, to the northwest (Figure 5.4).

While there are no recorded historic archaeological sites within the Project area, there is abundant documentary evidence that Europeans were settling the area perhaps as early as the late 17th Century. The south side of Fort Ellis, along the north bank of the Stewiacke River, is a broad salt marsh that proved to be an irresistible draw to the Acadians; in the early 18th Century we know that Pierre Hébert founded a small village and created arable land from the salt marsh using an extensive dyke system. Numerous maps of the 18th and 19th Centuries show the existence of villages, settlements, dykes, and military buildings.

In addition to the background research, a field survey was conducted along the pipeline route in order to examine high potential areas identified in the background research and to determine if other areas should also be considered high potential, particularly watercourses. Results of the survey show that the proposed pipeline route passes through relatively damp areas that were unlikely to be attractive to settlers.

The only area determined to have a high potential for containing historic archaeological resources is located approximately 100 m south of Riverside Road along the pipeline route (Figure 5.4). This area is

considered to have high potential for containing both First Nations and historic archaeological resources. The high potential area begins from the small ridge to the northeast of Riverside Road and includes the pipeline area as it descends to the river. The high potential area likely ends in the low areas that are located west and south of the ridges. Furthermore, the whole ridge running along the east side of the Shubenacadie and north of the Stewiacke and containing Village Hebere and Fort Ellis would also be considered high potential, but beyond the Project area.



alton
NATURAL GAS STORAGE LP

Alton Gas Storage Project

Figure 5.5 Archaeological and Heritage Resources: Areas of High Potential

Map Features

- Water Intake
- Brine Discharge
- Building (1997, NSTS, 10k)
- Proposed Pipeline Route (20m ROW)
- Proposed Surface Facilities
- Proposed Subsurface Facilities
- Holding Ponds
- Archaeological High Potential Area
- Bridge
- Major Highway
- Collector Highway
- Paved Road
- Unpaved Road
- Rail
- Utility Line
- Contour (5m)
- Watercourse
- Waterbody
- Property Boundary

NSDNR Delineated Wetland

- NSDNR Freshwater Wetland
- NSDNR Saltwater Wetland

Air Photos: Nova Scotia Aerial Photography, 2004

0 250 500 1,000
Metres

Map Parameters
Projection: UTM, NAD83, Zone 20
Scale 1 : 30,000
Date: June 06th, 2007
Project No.: 1012229.

Jacques Whitford

6.0 ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT

6.1 Fish and Fish Habitat

6.1.1 VEC Identification

The federal *Fisheries Act* defines “fish” to mean all fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals. Therefore, all aquatic organisms in habitats defined as fish habitat are considered as fish in this assessment.

The federal *Fisheries Act* defines “fish habitat" as spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly. Fish habitat includes physical (*e.g*., substrate, temperature, flow velocity and volumes, water depth), chemical (*e.g*., dissolved oxygen, pH, nutrients) and biological (*e.g.,* fish, benthic invertebrates, plankton, aquatic plants) attributes of the environment that are required by fish to carry out life cycle processes (*e.g.,* spawning, rearing, feeding, overwintering, migration). Fish and fish habitat, from the Shubenacadie Estuary are considered together as a VEC.

All pipeline crossings will be HDD under watercourses (if technically feasible) and no interaction is therefore expected between Project construction and operation and freshwater resources along the pipeline route. Prior to HDD activities, a geotechnical survey will be carried out to determine if HDD is technically feasible. If HDD is not practical given the underlying geology, alternative stream crossing methods will be developed in consultation with DFO and NSEL and supporting work will include detailed fish habitat assessments, permit application (if required), stream specific mitigation, sediment control plans and follow-up monitoring.

Aquatic organisms and habitat are valued in Nova Scotia for their intrinsic contribution to local, regional and international biodiversity. Species-at-risk (those species that are low in abundance and threatened with extirpation and/or extinction) require special attention during the assessment process as, by their very definition, populations and their habitat are more sensitive to anthropogenic stressors. In addition, specific legislation has been developed to protect aquatic species-at-risk (*e.g., SARA*), some of which are present in the assessment area. Therefore, species-at-risk and their habitat are the focus of this assessment. A precautionary approach to assessment aimed at the protection of species-at-risk also serves to protect lesser known aquatic organisms as well as those with larger populations. Fish in the Estuary are also valued for economic and cultural reason; fish populations in the Estuary and watershed have long been a source of subsistence for First Nations and continue to have a high cultural and economic significance to Aboriginal peoples of the area. Recreational and commercial fisheries also occur in the Estuary, which contribute to the local economy and culture.

6.1.2 Boundaries

Interaction between fish and fish habitat and the proposed Project is limited to the Estuary. The Estuary is the proposed site of brine discharge that will be produced during solution mining and the source of water used during the mining process and for the dilution of brine.

The majority of fish species known from the Estuary is migratory, and therefore present at particular times of the year. For instance, salmonids (brook and brown trout and Atlantic salmon) found in the Estuary are anadromous. Other anadromous species known to pass through the Estuary include sea lamprey, Atlantic sturgeon, striped bass, gaspereau, blueback herring, American shad and rainbow smelt. These species would be present in the Estuary seasonally, while migrating between spawning grounds farther upstream and marine foraging habitats. None of these species are known to spawn in the Estuary in the vicinity of the proposed diluted brine discharge or water withdrawal, although the eggs and larvae of striped bass may be present in the Estuary near the intake system. The Atlantic tomcod also migrates through the Estuary and may spawn in the vicinity of diluted brine discharge and water withdrawal. The catadromous American eel is also present in the Estuary during migration and may forage in the area of proposed discharge and water withdrawal throughout the year. Marine and euryhaline fish are expected throughout the year, with abundance varying over small (*i.e.,* tidal) and large (*i.e.,* seasonal) scales. Freshwater fish may penetrate the Estuary on occasion, especially after heavy rains. The migratory movements and spawning times of fish species found in the Estuary are further described in Section 5.4.

Fish and fish habitat are protected under the federal *Fisheries Act* and the Nova Scotia *Environment Act*. Species-at-risk are protected under the federal *SARA* and the Nova Scotia *Endangered Species Act*.

DFO has developed the *Policy for the Management of Fish Habitat* (1986), which applies to all development and industrial projects, both large and small, in or near watercourses that could alter, disrupt, or destroy fish habitat by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The policy is regulated in Sections 20, 30, 32, 35 and 36 of the *Fisheries Act*. The *Fisheries Act* is administered by DFO, except Section 36 (which deals with the control of deleterious substances in fish habitat) which is administered by Environment Canada in close cooperation with DFO. DFO also works in collaboration with NSEL to protect fish and fish habitat. As a result, all activities that could potentially affect fish and fish habitat must be approved in advance by DFO and NSEL, and in some cases, Environment Canada.

The ecosystem of the Estuary was described using existing published literature, technical reports, consultation with scientific experts and knowledge of the Study Team. Water quality parameters were described using field data collected specifically in support of the Project. However, at this point of Project development, there are several unknowns related to Project design. Thus, this assessment takes a precautionary approach to the assessment of impacts and delineates those effects that are not well understood and identifies areas where further work is required.

6.1.3 Residual Environmental Effects Evaluation Criteria

A **significant adverse environmental effect** on fish habitat is one that would result (either directly or indirectly) in:

- death or life threatening injury to one or more individuals of a listed species on Schedule 1 of *SARA*;
- death or life threatening injury on fish species in sufficient numbers to adversely affect species populations and ecological functioning of the fish community;

- long-term or permanent displacement of any species from preferred feeding, spawning or rearing habitats (including critical habitat for *SARA* listed species) or migratory routes;
- long-term exceedence of the CCME guidelines for the protection of aquatic life (CCME 1999);
- destruction or adverse modification of critical habitat (as defined by *SARA*); and/or
- an unmitigated or non-compensated net loss of fish habitat as defined in the *Fisheries Act*.

A **positive** effect is defined as one that enhances the quality of habitat, increases species diversity, and/or increases the area of valued habitat.

6.1.4 Potential Interactions, Issues and Concerns

Potential interactions between the Project and fish and fish habitat relate primarily to:

- health effects and mortality of fish and invertebrates due to increased or rapid fluctuations of salinity or other chemical and/or physical parameters caused by diluted brine discharge;
- disruption of migratory and foraging behaviour of fish due to increased or rapid fluctuations of salinity or other chemical and/or physical parameters caused by diluted brine discharge;
- loss and/or contamination of prey (fish and invertebrates) of mammals and birds;
- mortality of fish and other aquatic organisms due to water withdrawal;
- alteration of habitat and flows due to water withdrawal and diluted brine discharge; and
- hydrocarbon or chemical spills or uncontrolled brine release which may have toxic effects.

All pipeline crossings will be HDD under watercourses (if technically feasible). Riparian vegetation along stream crossings will be maintained during HDD wherever feasible. Vegetation management along the RoW will be conducted mainly by mechanical means and no herbicides will be used within 30 m of a watercourse. Herbicides are likely to be used on portions of the pipeline RoW that pass through agricultural lands as part of the farming practices pursued by the landowner. No interaction is therefore expected between Project construction and operation and freshwater resources along the pipeline route. If HDD is not practical given the underlying geology, alternative stream crossing methods will be developed in consultation with DFO and NSEL and supporting work will include detailed fish habitat assessments, permit application (if required), stream specific mitigation, sediment control plans and follow-up monitoring.

The discharge of brine produced during solution mining to the Estuary is a key environmental concern. The dominant dissolved salt in discharged diluted brine will be sodium chloride which is the major dissolved salt in seawater (and thus in the Estuary). Sodium chloride is a specific chemical compound which does not vary between sources. However, other elements may also be present in the salt core and therefore in diluted brine discharge. Salinity is typically measured in parts per thousand (ppt) and is a determining factor in the physical properties of water, such as freezing point, specific gravity, and osmotic pressure. Together, these properties have implications on the physiology and ecology of aquatic organisms. For example, elevated and/or rapidly fluctuating salinities may compromise the health and reproductive capacity of aquatic organisms and in some instances may cause death. Elevated and/or fluctuating salinities may also alter the spatial distribution and migratory movements of fish and other aquatic organisms. Other elements that may be present in the salt core and thus diluted

brine could elicit toxic or behavioural effects to fish and other aquatic organisms and the potential for these effects are also addressed in this assessment. It is noted however, that most of the organisms present in the Estuary near the Project water intake and discharge are naturally accustomed to wide fluctuations in salinity levels normally found at that location (see Section 5.3)

Water will be withdrawn from the Estuary to dilute the brine from the caverns prior to discharge. Water withdrawal could cause injury or death to fish and other aquatic organisms due to impingement or entrainment. There are concerns raised with respect to habitat alteration due to water withdrawal and diluted brine discharge (*e.g.*, entrainment of organisms).

There is also the potential for effects on fish and fish habitat due to the construction and ongoing presence of water withdrawal and discharge structures. Construction of the water withdrawal and discharge structures may lead to sedimentation and noise disturbance, and the presence of these structures may alter fish habitat.

6.1.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.1.5.1 Construction

Construction of the proposed Project has the potential to affect fish and fish habitat in the Estuary by way of three key pathways: 1) the discharge of diluted brine; 2) water withdrawal; and 3) habitat effects. These pathways and associated mitigation and residual environmental effects are discussed separately in the following sections.

Brine Discharge

The salt caverns which will be subject to solution mining consist predominantly of crystalline sodium chloride; however, other elements are also present, albeit at low levels. In order to quantify the risk of other elements eliciting toxic effects to fish and other aquatic organisms when discharged as diluted brine, a sample of the salt core was dissolved in distilled water and levels of metals were measured. The tested solution was prepared to mimic the discharge; saturated brine made by dissolving a sample of the salt core into distilled water (260 ppt) was diluted with distilled water so that the tested solution has a salinity of 26 ppt, which equates to approximately 10:1 dilution (distilled water to saturated brine). Total and available metals in the prepared solution were measured by Maxxam Analytical Laboratories. Maxxam Analytical Laboratories endeavored for detection limits at or below the Canadian Council of Ministers of the Environment (CCME) interim Canadian Water Quality Guidelines for the Protection of Aquatic Life, (CCME 1996); however, the presence of high levels of sodium chloride (salt) made it unfeasible to have detection limits at or below the CCME guideline limit for all metals (*i.e.,* cadmium, chromium, copper, iron, selenium, and thallium). The CCME guidelines limits that are below the detection limits generally pertain to limits identified for freshwater systems and the aqueous solutions tested was essentially seawater (~26 ppt) and thus Maxxam could not achieve detection limits at or below the CCME freshwater guidelines. Regardless, no exceptionally high levels of metals in the salt core were indicated and thus the present analytical results give a rough indicator of the potential risk that other metals in the salt-core pose to aquatic receptors (Table 6.1). However, as detection limits were above CCME guidelines in some cases the results of toxicity testing of the diluted brine on representative organisms will be important in further understanding the risk that metals in the discharge pose to aquatic receptors. In addition, more detailed analytical testing may be required on the brine (at

varying dilutions) if tested solutions are deemed to have toxic effects. The specifics of this toxicity testing program will be developed in consultation with regulators, most notably Environment Canada, see Section 6.1.6 for more discussion on this topic. CCME Guidelines are based on total levels (versus biologically available levels) and there are different guidelines for freshwater and marine systems. United States Environmental Protection Agency (US EPA) Toxicity Reference Values (TRVs) guidelines (ERD 1999) have been referenced to give context to results for metals for which no guidelines have been identified by the CCME. The Estuary is a transitory environment between a freshwater and marine system and thus both guidelines were reviewed and presented below in Table 6.1, along with the results of the analysis.

TABLE 6.1 Element Levels in Diluted (10:1) Brine

Elements	Units	Reported Level	Detection Level	CCME (Freshwater/ Marine)
Total Aluminum (Al)	ug/L	ND	100	5-100/NA
Total Arsenic (As)	ug/L	ND	0.1	5/12.5
Total Antimony (Sb)	ug/L	ND	20	160[a]
Total Barium (Ba)	ug/L	ND	50	4.0[a]
Total Beryllium (Be)	ug/L	ND	20	0.53[a]
Total Bismuth (Bi)	ug/L	ND	20	NA
Total Boron (B)	ug/L	ND	50	750[a]
Total Cadmium (Cd)	ug/L	ND	3	0.017/0.12
Total Chromium (Cr)	ug/L	ND	20	8.9/56
Total Cobalt (Co)	ug/L	ND	10	23[a]
Total Copper (Cu)	ug/L	ND	20	2-4/NA
Total Iron (Fe)	ug/L	ND	500	300/NA
Total Lead (Pb)	ug/L	ND	5	1-7/NA
Total Lithium (Li)	ug/L	ND	20	14[a]
Total Manganese (Mn)	ug/L	ND	20	120[a]
Total Molybdenum (Mo)	ug/L	ND	20	73/NA
Total Nickel (Ni)	ug/L	ND	20	25-150
Total Selenium (Se)	ug/L	ND	50	0.1/NA
Total Strontium (Sr)	ug/L	180	50	1500[a]
Total Thallium (Tl)	ug/L	ND	1	0.8/NA
Total Tin (Sn)	ug/L	ND	20	73[a]
Total Titanium (Ti)	ug/L	ND	20	NA
Total Uranium (U)	ug/L	ND	1	2.6[a]
Total Vanadium (V)	ug/L	ND	20	20[a]
Total Zinc (Zn)	ug/L	ND	50	300/NA
Available Cadmium (Cd)	ug/L	ND	0.1	See below*
Available Chromium (Cr)	ug/L	ND	0.5	See below*
Available Cobalt (Co)	ug/L	ND	0.1	NA
Available Copper (Cu)	ug/L	0.3	0.1	See below*
Available Iron (Fe)	ug/L	17	1	See below*
Available Lead (Pb)	ug/L	0.2	0.1	See below*
Available Manganese (Mn)	ug/L	2	1	NA
Available Nickel (Ni)	ug/L	ND	0.5	25-150/NA
Available Zinc (Zn)	ug/L	ND	1	See below*

*CCME Guidelines pertain to total metal levels

[a] Toxicity Reference Value (TRV) stipulated by the Environmental Restoration Division (ERD) of the US EPA

ND: Not detected, *i.e.,* levels below detection level

NA: No level stipulated by CCME or ERD

Solution mining will produce saturated brine. A variety of scenarios for discharge of brine have been proposed during the development of the Project design. Initially, the design entailed discharging saturated brine directly to the Estuary (see Section 2.7). However, in consideration of the sensitivity of the receiving ecosystem and species present, a precautionary approach an innovative design was adopted. The environmental design objective is to ensure that the salinity of discharge does not exceed 25 ppt, the approximate average upper limit expected at this location in the Estuary. This salinity target will be achieved by a series of holding ponds which will be used to hold brine, dilute brine with Estuarine water and control the discharge back to the Estuary. The water intake and discharge facilities are described in Section 2.1. The salinity of the diluted brine discharge into the Estuary is designed to approximately mimic, the natural variation in salinity in the Estuary. Brine will not be discharged during the last four hours of the ebb tide when salinities are lowest. The operation of the discharge facilities will be automated in order to synchronize discharges in accordance with the tidal cycle and the salinity targets.

Once the pre-diluted discharge flows into the Estuary, salinity level will further decrease quickly due to vertical and horizontal mixing of the discharge within the dynamic estuarine flows. Assuming maximum salinity level of 25 ppt for the discharge and 10 ppt for the Shubenacadie River, modeling results indicate that the decay of brine solution in the near field is most rapid within 30 m of the outfall. Beyond this point, the decay is more gradual. Predicted salinity (above ambient) at a downstream distance of 1000 m from the outfall is 1.77 ppt. Modeling results also indicate that the zone of influence is initially 20 m in width and reduces to 10 m in width at 150 m and 20 m in width at 1000 m from the point of discharge. It becomes vertically mixed within 250 m of the point of discharge (Appendix C).

Water volume withdrawn and discharged for the Project is small compared to the volume of water that passes through the Estuary in the vicinity of water withdrawal and diluted brine discharge during the tidal cycle. On a large tide, the ebb flow in the Shubenacadie River near the proposed Project location is over 8 million cubic metres per day and the flood flow is approximately 6 million cubic metres per day. For brining, the Project proposes drawing off 0.15% of total flow in the vicinity of the Project per day. For the purposes of dilution, approximately 100,000 m^3 per day will be drawn to the mixing pond and returned to the Estuary (1.25% of total flow). Small tidal range flows are approximately 50% of large tidal flows.

Owing to the nature of the Estuary, especially with respect to the presence of species-at-risk, a literature review and consultation with species experts was conducted. Findings focused on: 1) toxic effects of brine (including the effects of dissolved sodium chloride and other chemical species) on fish and other aquatic organisms; and 2) the potential of brine discharge to alter, halt or otherwise compromise migratory movements of diadromous fish.

Salinity levels in the Estuary in the area of proposed Project are naturally variable in time and space, and thus organisms in the Estuary have evolved to cope with fluctuating salinities by using behavioural or physiological strategies. Many of the fish species present in the Estuary are diadromous and are thus capable of living in both full seawater and freshwater and are generally not particularly sensitive to minor fluctuations in salinity. However, all fish species have upper lethal limits for salinity. Death occurs as a result of osmoregulatory shutdown and subsequent cell damage. The upper lethal salinity levels for fish vary by species, health and life stage and other physical and chemical conditions, such as water temperature. Little data exists on the upper lethal limits of salinity for fish species native to the Estuary. However, diadromous and euryhaline species present in the Estuary are capable of living at full ocean salinities (approximately 35 ppt); therefore, the upper lethal salinity for these species is greater than 35

ppt. Effluent will not exceed a salinity of about 25 ppt, well below ocean salinities and therefore is not predicted to elicit toxic effects to diadromous or euryhaline fish species. Freshwater fish species likely only penetrate the Estuary during times of low salinity and would avoid areas of heightened salinity caused by diluted brine discharge. Avoidance behaviour could result in shifts to the distribution of predominately freshwater species in the Estuary. However, as freshwater fish species potentially present in the Estuary are common and do not spawn in the Estuary, no measurable effects are predicted at the population level. The diluted brine zone of influence will be localized (Appendix C) and no discharge of diluted brine will occur during the last four hours of the ebb tide when salinities are lowest, further minimizing the potential for diluted brine discharge to affect predominantly freshwater fish species that may use the Estuary.

Diadromous and some euryhaline fish undergo physiological changes when transitioning from marine to freshwater environments (and vice versa). However, most species cannot move directly from one environment to another, rather they require an acclimatization period in intermediate salinities in which physiological changes can occur. The salinity level of the discharged diluted brine and mixing of the diluted brine in the Estuary precludes the formation of steep salinity gradients that would necessitate fish to undergo an abnormal process of acclimatization. For example, Atlantic salmon and sturgeon are capable of living in full seawater and freshwater. Sensitive life stages of Atlantic salmon (eggs and alevins) and sturgeon (eggs and larvae) are not known to occur in the Estuary thus limiting interaction with discharge.

There is some species-specific information available relating to the potential effects of elevated salinities on fish species found in the Estuary. Research on the influence of salinity on growth and survival of striped bass from the Shubenacadie watershed has been conducted at the Truro Agricultural College. Under experimental conditions, Duston *et al.* (2004) determined that growth of juvenile striped bass was largely independent of salinity. Furthermore, juvenile striped bass are euryhaline capable of tolerating rapid fluctuations in salinity (Duston *et al.* 2004). Therefore, the increases in salinity in the immediate area of discharge are not predicted to have significant effects on juvenile striped bass which may forage in the area. Interaction between discharged diluted brine and spawning fish is unlikely as striped bass spawn at the head of the tide in the Stewiacke, which is outside of the zone of predicted influence of diluted brine discharge.

The planktonic life stages of bony fishes (eggs and larvae) are likely to be more sensitive to fluctuations in salinity than adult fish due to the inability of drifting larvae and eggs to actively move from areas of contamination and physiological sensitivities. Mummichogs, sticklebacks and Atlantic tomcod likely spawn in the Estuary in the vicinity of the Project area and striped bass larvae and eggs are present at certain times of the year. Mummichogs and sticklebacks are typically found in shallow coastal waters, estuaries and salt marshes and have evolved to deal with fluctuations in salinity. Thus, the salinity of discharge at a maximum level of 25 ppt is not expected to elicit mortality of eggs and larvae of these hardy species. Striped bass eggs and larvae occur at certain times of the year (*i.e.,* late May and early June) in the area of discharge and water withdrawal (R. Bradford, pers. comm., 2007). However, as salinities in the Estuary are known to be as high as 27 ppt and effluent will have a maximum salinity of 25 ppt (which will be rapidly diluted) it is unlikely that diluted brine discharge will elicit mortality of striped bass eggs and larvae. Moreover, if high densities of eggs or larvae are located in the vicinity of the Project, an operational shutdown has been proposed to minimize impingement and entrainment of early life stages of striped bass due to water withdrawal. This measure will have the added benefit of

reducing exposure to any elevated salinities from the Project during this time period. This operational shutdown to avoid striped bass egg and larvae mortality is described in more detail below.

The winter spawning of Atlantic tomcod in the Estuary and potential interaction with diluted brine discharge also raises concerns. Tomcod eggs require a freshwater influx and do not develop normally when continuously exposed to 30 ppt salinities (Peterson *et al.* 1980). Effects of diluted brine discharge on Tomcod eggs is unlikely because the salinity of diluted brine discharge will not exceed 25 ppt, discharge will not occur during the last four hours of the ebb tide when salinities are lowest and diluted brine will be rapidly diluted in the Estuary. Therefore, discharge of diluted brine is not expected to affect the development of tomcod eggs or larvae.

Mink, otter and other aquatic-related mammals could be affected if their fish prey is adversely affected. However, no population level effects are predicted on common fish species which likely comprise the majority of these mammals' diets, and thus no effects are predicted on aquatic-related mammals.

The dominant benthic invertebrate in the study area is likely *C. volutator*, a keystone species due to its importance as prey for a variety of migratory shorebirds and fishes. *C. volutator* is a euryhaline species found in a wide range of salinities, preferring a salinity range of 10-30 ppt (McLusky 1970). McLusky (1970) conducted a series of trials whereby *C. volutator* were placed in tanks where a variety of different salinity zones were available. At salinities between 10-30 ppt, *C. volutator* showed no significant patterns of choice. However, at salinities below 10 ppt, *C. volutator* significantly chose the highest available salinity, and in the range of 30-40 ppt, they chose the lowest available salinity. Individuals did not exhibit a significant choice pattern in the range of 40-50 ppt, likely due to their lethargic state at these high salinities. *C. volutator* have been shown to tolerate salinities up to 50 ppt for long periods (over 500 hours). Although physiologically capable of tolerating high salinities, the growth rate and development of *C. volutator* is likely compromised as moulting that is necessary for growth is highest within the range of 5-20 ppt. Discharged diluted brine will not exceed a salinity of 25 ppt, which is well below the lethal salinity level for *C. volutator* and will not occur during the last four hours of the ebb tide when salinities are lowest. Furthermore, according to McLusky (1970), the maximum salinity of discharged water will not alter the distribution patterns of *C. volutator*. As such, no adverse effects are predicted on *C. volutator* populations in the Estuary due to the effects of diluted brine.

C. volutator is a keystone species in the Estuary due to its importance as a prey item for a number of migratory shorebirds and fishes. Therefore, migratory shorebird and fishes in the Estuary could be affected if the population of *C. volutator* was compromised. However, no effects are predicted on the *C. volutator* population in the Estuary (see above) and thus no effects are predicted on migratory shorebirds or shorebirds insofar as their prey supply is concerned.

Salmonids are well known for the ability to return to their natal streams for spawning. The mechanics of this process are poorly understood; however, this ability likely arises in part from the ability of young fish to learn specific odours during freshwater residence and seaward migration and seek out these odours as mature fish. It is thought that most anadromous fish locate natal streams using similar olfactory cues. Thus, the migratory movements of anadromous fish in the Estuary are closely linked to the unique odours imparted by dissolved organic and inorganic matter in the water. The risk of fish becoming disoriented due to the presence of diluted brine is difficult to gauge given the lack of information regarding this behaviour. For instance, it is not known if a particular odour is required continually throughout the upstream migration or if the initial perception of an odour triggers upstream

movement and is not required thereafter. In addition, the exact odorants which trigger responses in fish are not known, and likely vary by species.

The risk of discharged diluted brine causing disruptions to migratory movements is minimized by several Project design features. The first is that Estuary water will be used for solution mining and for the dilution of produced brine to meet the salinity target; therefore, any important odorants present in the Estuary water will remain in the discharged diluted brine. In addition, the chemistry analysis suggests (Table 6.1) the salt core is predominantly sodium chloride and thus is not expected to add a complex of other, unfamiliar odorants. Dilution of brine in the Estuary will be high. The maximum daily water withdrawal from the Estuary, required to create the salt caverns, will be 11,750 m^3, which signifies a dilution factor of brine in Estuary water of approximately 800. Discharge will also be diluted to a maximum salinity of 25 ppt (typically a 10:1 dilution of Estuary water to brine) prior to discharge and discharge will be rapidly dispersed in the Estuary due to natural horizontal and vertical mixing, further reducing the risk of disorientating migratory fish. No discharge will occur during the last four hours of the ebb tide when salinities are lowest, consequently there will be a window of time each day when there is no potential for discharge disrupting migration. In summary, there is a low risk of discharge disorientating migrating fish, including salmonids, and effects are therefore considered unlikely.

In summary, no acute or sub-lethal toxic effects on fish and other aquatic organisms due to discharged diluted brine are expected and thus no significant adverse effects are predicted. However, there is some degree of uncertainty surrounding the potential of discharge to disrupt migratory movements of anadromous fish, particularly salmonids. The use of estuarine water to solution mine and dilute resultant brine as well as the rapid dilution of discharge significantly reduces these risks.

Water Withdrawal

Water withdrawal raises concerns over the entrainment or impingement of adult fish, juveniles, larvae and eggs. Water will be withdrawn from the Estuary to solution mine and to dilute saturated brine. Entrainment occurs when a fish is drawn into a water intake and cannot escape. Impingement occurs when an entrapped fish is held against an intake screen and is unable to free itself. To minimize the risk of impingement and entrainment, DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines (1995) will be consulted in the design and maintenance of intake pipes. DFO will also be consulted on an ongoing basis during the design of water withdrawal infrastructure and the development of monitoring.

Entrainment and impingement of striped bass eggs and larvae has been identified as a key concern due to the special status of striped bass and the importance of the Estuary as spawning and rearing habitat. The Proponent has committed to a monitoring program for striped bass eggs to determine the necessity for additional mitigative measures to ensure negligible mortality of early life stages of striped bass due to impingement or entrainment. In particular, the Proponent has discussed with DFO representatives the possibility of an operational shutdown during the striped bass spawning period. The timing and length of this shutdown will be determined by monitoring results and consultation with DFO species experts. Operational shutdown would be a viable mitigative measure if large numbers of eggs and/or larvae are present near water withdrawal and discharge locations. DFO species experts will be consulted to determine what density of eggs would trigger an operational shut-down. In addition, an operational shutdown would be timed to occur during the period when egg densities are highest in the zone of influence. It is expected that an operational shutdown would last two weeks to encompass

the striped bass window. This adaptive management strategy utilizing monitoring results and guidance derived from ongoing consultations will enable protection of early life stages of striped bass while avoiding unnecessary operational shut-downs. The frequency of impingement and entrainment will also be minimized by the employment of DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines (1995) during design and maintenance of intake facilities; nevertheless, some mortality of striped bass eggs and larvae could occur during the life of the Project. It is expected that the striped bass will be added to Schedule 1 of *SARA* during the operational life of the Project, which may require an incidental harm permit issued by the Minister of Fisheries and Oceans Canada. This incidental harm permit will be issued by the Minister only if it is clear that the survival of the species will not be jeopardized. Therefore, further work will be required by the proponent when final Project details are available (*e.g.*, intake screening design) to quantify potential mortality of striped bass eggs and larvae and to consult with DFO on the risk that estimated incidental take poses to the population of striped bass. However, the predicted effect is not considered to pose a risk to the striped bass population since the proportion of the total population that would potentially be harmed by water intake is small. Planktonic life stages of fishes generally have high levels of natural mortality and any limited mortality due entrainment or impingement is unlikely to significantly exceed natural variability of population numbers to these early life stages. While numbers of adult fish present in the Estuary are not known, anecdotal information suggests that striped bass are very common (Local fishers reported at open house, November 2006). In addition, the proponent has committed to undertaking follow-up surveys of striped bass eggs and larvae in the vicinity of the water intake and discharge.

Inner Bay of Fundy Atlantic salmon migrate through the Estuary during upstream and downstream migration of adults and smolts. The migratory movements of salmon are fairly loose and fish may be present in the Estuary from early spring to late fall. Mortality of Atlantic salmon due to entrainment or impingement is not predicted. First, adult salmon and smolts are powerful swimmers and thus not as prone to impingement or entrainment as passive, drifting life stages and adult salmon and smolts do not stage in the Estuary for more than a day or two, thus reducing the time of potential interaction. In addition, the use of DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines during design and maintenance of water withdrawal infrastructure reduces the risk of impingement or entrainment of Atlantic salmon. Water withdrawal is not expected to result in salmon mortality.

Adult sturgeons are large, powerful fish and are not vulnerable to impingement or entrainment. Sturgeons spawn at the head of tide in freshwater, which is beyond the Project area. Eggs and larvae are associated with the bottom and are not expected to be found in the vicinity of water withdrawal. Juvenile sturgeons move into brackish water and are likely found in the Estuary in the area of water withdrawal; however, the Proponent will abide to design and maintenance protocols delineated in DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines (1995), thus reducing the risk of impingement and entrainment. Juvenile sturgeons are benthic feeders hence are closely associated with the bottom and likely remain in deeper reaches of the Estuary, which further reduces the risk of impingement and entrainment as water withdrawal infrastructure will be located along the banks of the Estuary. Water withdrawal is not expected to result in sturgeon mortality.

In summary, no significant effects on non-threatened fish populations are predicted due to water withdrawal as DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines (1995) will be followed and DFO will be consulted throughout the design of water withdrawal infrastructure and maintenance. There is some degree of uncertainty surrounding the potential of water withdrawal to cause mortality of

striped bass eggs and larvae and thus pending additional monitoring, an incidental harm permit may be required if *SARA* designation is applied. Further analysis on this subject is required; however, in consideration of the large numbers of eggs and larvae in the Estuary and an operational shutdown of water withdrawal during the striped bass spawning period, effects at the population level due to water withdrawal are unlikely. No mortality of Atlantic salmon or Atlantic sturgeon is expected due to impingement or entrainment. Monitoring of water withdrawal infrastructure will be used to confirm predictions of low or non-existent mortality (Section 6.1.6).

Habitat Effects

The final design of the water intake and outflow structures is not available; however, the footprint of these structures may intrude into the intertidal zone and below the low-tide mark and alter a small area of fish habitat. Potential additional permitting requirements (if any) including habitat compensation will be evaluated in consultation with relevant regulators when final design plans are available. In any event, it is expected that potential habitat loss associated with subtidal construction (if any) would be small compared with the width of the Estuary channel. In addition, there is the potential for effects due to the construction of the water intake and outflow structures on fish habitat in the Estuary; however, the nature and severity of effects are difficult to infer at this stage of project development given that only preliminary designs available. The effects of construction of the water intake and outflow structures will be assessed during the additional permitting process, if deemed necessary by DFO. Mitigative strategies to control erosion and sedimentation of surface waters are described below. There will be no blasting in or near the Estuary.

Flow and water levels are an important element of physical fish habitat. The maximum daily water withdrawal from the Estuary, required to create the salt caverns, will be 11,750 m^3. At the beginning of the formation of a cavern, the withdrawal is significantly less. However, the average daily diluted brine discharge or return flow to the Estuary from the caverns is about 90% of the withdrawal, and thus no impacts on flow and water levels in the Estuary are expected. In effect, the water that will be withdrawn and discharged is small compared to the volume of water that passes through the Estuary in the vicinity of water withdrawal and diluted brine discharge during the tidal cycle. On a large tide, the ebb flow in the Shubenacadie River near the proposed Project location is over 8 million cubic metres per day and the flood flow is approximately 6 million cubic metres per day. For brining, the Project proposes drawing off 0.15% of ebb flow in the vicinity of the Project per day. For the purposes of dilution, approximately 100,000 m^3 per day will be drawn to the mixing pond and returned to the Estuary (1.25% of ebb flow). Small tidal range flows are approximately 50% of large tidal flows.

Salinity changes have been shown to cause changes in the stability of mudflats in situations where salinity levels are significantly reduced (Pheeney, pers. comm. 1995). Discharge will not lower the salinity in the Estuary, and thus no effects on mudflat stability are predicted. In addition, the stability of the mudflats may be compromised if salinity changes affect primary producers which live in the upper layers of sediments (Paterson and Daborn 1991, Amos 1990). The benthic primary producers that may be found on mudflats in the vicinity of discharge are euryhaline species capable of withstanding fluctuating salinities. Any localized, minor increases in salinity due to discharge are therefore not predicted to change benthic primary producer communities in terms of their distribution or ecological functions. Dispersion of the discharged diluted brine will occur rapidly and no long-term, cumulative effects due to increased salinity are predicted as the majority of water in the Estuary is exchanged in a tidal cycle.

Sedimentation of the Estuary due to Project construction (including solution mining and construction of water intake and outflow structures) is not considered a threat to fish habitat due to the baseline conditions in the Estuary and mitigation that will be employed during construction and operation of the Project. Biological communities in the Estuary are not particularly sensitive to suspended solids given the high natural levels of suspended matter in the water column and the shifting, fine-grained substrates. Diluted brine will be held in settling ponds prior to discharge which will facilitate settling of suspended solids. Removal of sediment from ponds may be required; however, in such cases, intakes and outlets will be closed off to avoid introduction of large amounts of sediment to the Estuary. The Project specific EPP will include further mitigative strategies for reducing the risk of sedimentation and erosion during construction activities in proximity to the Estuary, such as:

- coordinate construction activities with seasonal constraints (*e.g*., time clearing, grubbing, and excavation activities to avoid heavy precipitation; avoid sensitive periods for fish and wildlife; shut down and stabilize the work site in accordance with pre-established criteria in advance of the winter season);
- implement measures in advance of grubbing and excavation activities, that will allow surface drainage to be diverted around the work area;
- install all perimeter control structures (*e.g.,* silt fencing, sediment traps, settling ponds) prior to any land disturbance;
- maintain vegetated buffer zones as appropriate to protect environmental values*;*
- minimize the exposed soil area (by limiting the area that is exposed at any one time and by limiting the amount of time that any area is exposed);
- stabilize exposed soil as soon as possible (*e.g.,* stabilize interim exposed soil with mulch, erosion control blankets or final exposed soil with fast-growing, non-invasive, native vegetation); and
- maintain sediment control structures (by inspecting and repairing structural problems during and after storm events, removing accumulated sediment at regular intervals or at designated capacities, and by disposing of it at an approved site, given its unsuitability as structural fill material).

In summary, no significant adverse effects are expected on fish or fish habitat due to construction of the Project.

6.1.5.2 Operation and Maintenance

As described in Section 2.1 there will be occasional hydrostatic testing of the caverns using Estuary water. Hydrostatic testing is an important precautionary, safety element of cavern maintenance and is required by CSA Standard Z341. Water withdrawal and discharge facilities used during cavern development will be used for the withdrawal and discharge of hydrostatic test waters and hydrostatic test water will be discharged into the Estuary. Similar to the cavern development phase, salinity of discharge will not exceed 25 ppt. Potential effects of diluted brine and water withdrawal are similar to those identified during the construction phase, except that the risk of effects is reduced given that discharge will occur infrequently (once every ten years for each cavern) and volumes of withdrawal and discharge will be lower. Natural gas will not leave residues on cavern walls and there will be no additives to Estuary water used for hydrostatic testing, thus minimizing the potential for toxic effects on fish and other aquatic organism in the Estuary. Nonetheless, toxicity testing will be conducted on

hydrostatic test water prior to discharge to verify that hydrostatic test water destined for discharge is non-toxic. The details of toxicity testing will be developed in consultation with regulators.

Other hydrocarbons may be stored in the caverns in the future. In cases where there is the potential for hydrocarbon residues on cavern walls, hydrostatic test waters will not be discharged into the Estuary. Test waters will be stored in secure facilities (*e.g.,* lined and enclosed pond) and re-used for further testing. Impacted surface waters will ultimately be disposed of in a licensed facility. No deleterious substances will be discharged into the Estuary and relevant guidelines will be followed. No other ongoing interactions are anticipated between operation and maintenance of the Project and fish and fish habitat.

In summary, no significant adverse effects are expected on fish or fish habitat due to operation and maintenance of the Project.

6.1.6 Follow-up and Monitoring

A variety of monitoring and follow-up programs will be initiated during the cavern development phase of the Project to verify predictions of this assessment and, if required, re-assess mitigation to ensure no significant effects on fish and fish habitat. Project details have not been confirmed, as such, the following text describes potential monitoring and follow-up programs in general terms. It is recognized that these monitoring programs will be refined and developed in consultation and collaboration with regulators and other stakeholders.

Salinity will be measured in the Estuary at the site of water withdrawal and discharge on an ongoing basis. *In situ* salinity meters will be used to quantify tidal and seasonal changes in salinity levels and data loggers will be used to determine statistics such as maximum and minimum salinities, mean salinity by tide cycle and variance. These data will be incorporated into the Project design in terms of determining salinity of discharge to mimic natural variability in the Estuary.

Assessing the toxicity of brine on representative organisms prior to discharge of diluted brine to the Estuary will be necessary. The test solution would consist of saturated brine from the salt core diluted to mimic the upper-target salinity level of discharge at the outlet of the holding pond (*i.e.,* 25 ppt). Further toxicity testing could be conducted throughout the cavern development phase of the Project using actual discharge. The specifics of such a testing program will be developed in consultation with regulators.

Monitoring of discharge salinity will occur continuously throughout the solution mining phase of the Project. Automated controls of water intake and diluted brine discharge will use this constant data-feed to refine intake and outflow volumes according to the salinity in the Estuary and the discharge.

Biological monitoring will occur before and during solution mining. Monitoring of water temperature and the presence of striped bass eggs and larvae will occur during one spawning season prior to the commencement of solution mining. Egg and larvae densities will be calculated by volume of water in order to estimate potential levels of mortality due to water withdrawal. In addition, ongoing monitoring of striped bass eggs and larvae will be conducted during the operational life of the Project to routinely evaluate the need for an operational shutdown during the striped bass spawning period. Monitoring data will provide valuable information to determine the specifics of an operational shutdown (if deemed necessary) such as timing. Monitoring of striped bass eggs and larvae will be coordinated in

consultation with DFO species experts. Monitoring will also occur as part of the maintenance program of fish screens on passive water intakes to determine if impingement is occurring.

6.1.7 Summary of Residual Environmental Effects Assessment

The adverse residual environmental effects on fish species not considered at-risk, and fish habitat, are not likely to be significant for all Project phases. Significant adverse residual effects on fish species-at-risk are not considered likely, but mortality of striped bass eggs and potentially larvae could occur due to water withdrawal. However, the design and maintenance of water withdrawal infrastructure (to comply with pertinent DFO guidelines) and operational shutdown during sensitive striped bass spawning periods is predicted to reduce mortality of striped bass eggs and larvae to very low levels that will not likely threaten this species in the watershed. The life stages of Atlantic salmon and Atlantic sturgeon present in the Estuary are not expected to be vulnerable to entrainment and/or impingement in water withdrawal structures. No mortality of Atlantic salmon or Atlantic sturgeon is predicted to occur during water withdrawal activities.

The disruption of migratory movements of fish in the Estuary due to diluted brine discharge cannot be discounted given the many unknowns with regard to the mechanics of fish migration. However, the use of Estuary water to solution mine, the relative purity of the salt core, and the dilution of brine reduces the risk of contributing or removing important odorants that may be used by migrating fish and thus the likelihood of effects, by way of disrupted migration, are very low.

The Proponent acknowledges that there is a degree of environmental risk involved in Project development that cannot be completely eliminated. A precautionary approach to environmental management of the brining system has therefore been taken including innovative design and engineering. The current design minimizes the risk of effects on fish and fish habitat as much as possible and therefore significant effects due to the Project on fish and fish habitat are unlikely to occur. The Proponent recognizes the unique sensitivities of the Estuary and the concerns of regulators and other stakeholders and is therefore committed to ongoing consultation and cooperation with regulators and stakeholders to further minimize environmental risks. Monitoring and follow-up, described previously, will be an integral part of confirming the predictions of this assessment and will provide opportunities for further research on the Estuary, the Project and potential interactions.

6.2 Rare and Sensitive Flora

6.2.1 VEC Identification

Vegetation with a focus on rare and sensitive species was selected as a VEC because rare and sensitive plant species are elements of indigenous biodiversity and are often indicative of rare habitats that harbour unique assemblages of plants and animals. Preservation of rare plant species often ensures that rare habitats and their unique assemblages of species are preserved. Rare species are designated in the following ways:

- Listed as a species at risk at the national level under the federal *SARA*;
- Listed as a species at risk under the Nova Scotia *Endangered Species Act*;

- Listed by NSDNR as a “red” or “yellow”-listed species or as status “Undetermined”; and
- Listed as very rare (S1), rare (S2) or uncommon (S3) in Nova Scotia by ACCDC.

The VEC assessed in this section is the Nova Scotia population of any vascular plant species listed as at risk, rare or uncommon in Nova Scotia or Canada.

6.2.2 Boundaries

The spatial boundary for the Project includes the Project footprint, where activities associated with site preparation and construction, operation, and malfunctions and accidents of the Project could potentially result in environmental effects on rare plants. The environmental effects of the loss of a rare plant population are assessed within the context of the regional biogeoclimatic zones that the species is found in. Wetlands were not assessed as the current preliminary Project design avoids all wetlands. However, should wetlands be determined to be unavoidable upon final design of pipeline routing and location of the mixing pond and other aboveground structures, full wetland evaluations will be conducted according to provincial policy and guidelines, and permit applications submitted with habitat compensation proposals.

The temporal boundaries of the Project include the periods of construction, and subsequent operation and maintenance of the Project. Plants can be affected by Project activities any time of year, although certain Project activities (*e.g.,* clearing and vehicle movements on wetlands) may preferentially be conducted on frozen ground to minimize damage to plant root systems in areas not intended for grubbing.

Information regarding rare plants within the Project area was derived from a combination of sources including existing literature and field surveys. Existing data sources included an ACCDC rare plant data search for an area extending 100 km around the Project area. This data combined with habitat information for the proposed pipeline route was used to help predict what rare plants may be present along the route and identify habitat types along the route that should be searched during the field survey.

Field surveys were conducted between June 27 and 29, 2006 and on August 9, 10, 11, 14 and 17, 2006 to determine if any uncommon, rare or sensitive plant species were present along the proposed pipeline route and in the area adjacent to the proposed discharge site. The entire pipeline route was walked with the exception of some active agricultural lands. Particular attention was paid to habitats identified in the rare plant modeling exercise as having high potential to support populations of rare plants. These included riparian habitats, wetlands and rich hardwood stands. In instances where uncommon, rare or sensitive plant species were encountered, their location was recorded with a global positioning system and the number of plants present was recorded.

6.2.3 Residual Environmental Effects Evaluation Criteria

SARA and the Nova Scotia *Endangered Species Act* protect species at risk. There are different levels of protection afforded a species within these Acts depending upon the species rarity ranking. For example, only those species currently listed in Schedule 1 of *SARA* are protected by that Act. Furthermore, *SARA*-listed species designated as “Species of Special Concern” are not protected by the prohibitions of Sections 32-36 of *SARA*, but do require that provincial or regional management plans be developed to protect the species within a specified timeframe. There are also several agencies that

provide lists of species of conservation concern that are not protected by an Act, but that do require special consideration for the purpose of environmental assessment. As a result, several significance criteria are required to accommodate the different levels of protection afforded by these various Acts, agencies and listings.

A **significant residual adverse environmental effect** on all species listed in Schedule 1 of *SARA* as "Extirpated", "Endangered" or "Threatened" or listed by the Nova Scotia *Endangered Species Act* as "Endangered" or "Threatened" is one that results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA*, or in contravention of any of the prohibitions stated in Section 13 of the Nova Scotia *Endangered Species Act*.

A **significant residual adverse environmental effect** on species of conservation concern not under the protection of *SARA* or the Nova Scotia *Endangered Species Act* (*i.e.,* listed in *SARA* but not as "Extirpated", "Endangered" or "Threatened" in Schedule 1; listed as "Species of Special Concern" within Schedule 1 of *SARA*; or ranked as "S1", "S2", or "S3" by ACCDC and also (where available) ranked "red" or "yellow" by NSDNR is:

- one that alters the terrestrial habitat within or adjacent to the Project area physically, chemically, or biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a viable population that is dependent upon that habitat such that the likelihood of the long-term survival of these rare, uncommon and/or non-secure population(s) within or adjacent to the Project area is substantially reduced as a result; and/or
- one that results in the direct mortality of individuals or communities such that the likelihood of the long-term survival of these rare, uncommon and/or non-secure population(s) within or adjacent to the Project area is substantially reduced as a result; and/or
- in the case of species of special concern listed in Schedule 1 of *SARA*, where the Project activities are not in compliance with the objectives of management plans (developed as a result of Section 65 of *SARA*) that are in place at the time of relevant Project activities.

A **positive** effect occurs when Project activities increase species populations and/or diversity.

6.2.4 Potential Interactions, Issues and Concerns

Rare and sensitive plant populations found along the route could be affected by a variety of activities during construction. Clearing and grubbing would be most likely to adversely affect rare plant populations. Sedimentation of wetlands or rivers could alter soil conditions or smother, wetland or aquatic habitats that support rare plant species.

Uncommon or rare estuarine species could be affected by the Project if the salinity of the diluted brine discharged into the river exceeds their salinity tolerance. The potential for rare estuarine species present in the study area to be affected by the Project will depend on the level of salinity that they are able to tolerate, the amount of diluted brine released, where the diluted brine is discharged, the phase of the tide that it is discharged on, and whether the diluted brine is diffused into the water column.

Rare and sensitive terrestrial plant species could be affected by vegetation maintenance activities such as mechanical clearing and herbicides. The proponent will not be applying herbicides; however, herbicides are likely to be used as part of the farming practices pursued by the landowner on portions of the pipeline RoW that pass through agricultural land.

6.2.5 Analysis, Mitigation and Residual Environmental Effects Prediction

This section provides an analysis of the environmental effects of the key Project-Vegetation interactions by Project phase, including a discussion of planned mitigation.

6.2.5.1 Construction

Clearing and grubbing for site preparation will remove vegetation and can change the quality of the habitat along the edge of the proposed pipeline RoW and other Project facilities. Vegetation and habitat within the Project footprint will be permanently altered, though regrowth of low growing species will be allowed within the pipeline RoW. Forest clearing will alter the habitat along the edge of the Project footprint, allowing shade intolerant species to colonize areas that were previously shaded understory, potentially reducing the suitability of the habitat for slow growing shade tolerant species. Six of the nine uncommon or rare plants identified during the field surveys can be expected to be directly affected by site preparation activities. These include alderleaf buckthorn, green sedge, crowded sedge, variegated horsetail, Bicknell northern crane-bill, and retrorse sedge. The other three species were not encountered in or in close proximity to the Project footprint.

Approximately 90% of the alderleaf buckthorn found during the field surveys is located outside of the Project footprint and is not expected to be adversely affected. The three alderleaf buckthorns that are found within or at the edge of the proposed RoW could be avoided by shifting the pipeline route to avoid them if such a route alteration is practical and does not encounter additional constraints. Supplemental surveys would be required to ensure that any new routing would not adversely affect other rare plants or environmentally sensitive areas.

Both green sedge and crowded sedge were found in recent clear-cuts and were particularly abundant along skidder trails where mineral soil was present. Green sedge was found at six locations in the eastern half of the proposed pipeline route. This species was most abundant in the vicinity of Alton. All but one of the six patches of green sedge found during the field surveys were located in or immediately adjacent to the proposed pipeline route and could be lost as a result of construction activities. Crowded sedge was recorded at five locations all of which could be disturbed by construction activities.

The loss of these populations could be mitigated by shifting the pipeline to avoid these known locations if such an alteration is practical and does not encounter other constraints. However, it is very likely that these species are widely distributed throughout the recent clear-cuts at the eastern end of the pipeline route. Field surveys would be conducted in conjunction with any route alterations to determine if any rare species are present on the new route. If the field surveys reveal that this species is widespread and it is not practical to establish an alternative route that avoids all of the rare species, a route that is both practical and affects the minimum number of rare plants will be selected. Both green sedge and crowded sedge prefer disturbed habitats. Construction of the RoW can be expected to increase the amount of suitable habitat for both species. Re-establishment of both of these species would be enhanced by temporarily stockpiling and replacing the topsoil from the trenched area. This material would provide a source of viable seed and root systems of these species that would aid in their re-establishment.

All of the Bicknell's northern crane-bill are located in or in close proximity to the proposed pipeline RoW and could be lost as a result of pipeline construction. This species was found in the same habitats and general locations as green sedge and crowded sedge. Shifting of the pipeline route could be used to avoid these known populations of Bicknell's northern crane-bill; however, it is highly likely that this

species, like the two sedge species, is widely distributed on the clear-cuts and is intermingled with green sedge and crowded sedge. If it is not practical to establish a route through these clear-cuts that avoids the two sedge species and the Bicknell's northern crane-bill, the route that minimizes disturbance to the more sensitive sedge species will be selected. As with green sedge and crowded sedge, Bicknell's northern crane-bill can be expected to colonize the new pipeline RoW particularly if the RoW is top dressed with grubbings and topsoil removed from the trench.

The variegated horsetail population found west of Highway 102 is outside of the proposed RoW and is not expected to be affected by pipeline construction.

The retrorse sedge population recorded on the proposed RoW can be expected to be lost as a result of construction activity. It is not advisable to avoid this population by shifting the pipeline route since it is located in a narrow corridor of upland habitat between two wetlands. Shifting the route would probably result in damage to one of these wetlands. This population is located near a stream which will be crossed using HDD. It should be possible to extend the directional drill such that the pipeline passes under the retrorse sedge population, Depending in the final design, Alton will make a reasonable attempt to do this, and if it is not feasible, Alton will consult with NSDNR regarding site specific mitigation.

It is recommended that a variety of species of plants native to the general project area be used in revegetation efforts. Should seed mixes for herbaceous native species for the area not be available, it should be ensured that plants used in revegetation efforts are not known to be invasive.

Measures to reduce the risk of introducing invasive species will also be developed and implemented. These measures include: cleaning and inspecting construction equipment prior to use within the Project area (*e.g.,* use of pressure water hose to clean vehicles prior to transport); and regularly inspecting equipment prior to, during and immediately following construction in areas found to support purple loosestrife (*Lythrum salicaria)* to ensure that vegetative matter is not transported from one construction area to another.

Provided the mitigative measures are followed, residual adverse environmental effects on vegetation are predicted to be not significant for the construction phase of the Project. It is acknowledged that avoidance of some rare or sensitive plant species (*e.g.,* through adjustment of RoW or HDD/boring) may not be technically or economically feasible or otherwise practical due to other environmental or socioeconomic constraints. In such case, the proponent will consult with the relevant regulatory authorities (primarily NSDNR) to develop an alternate mitigation plan. It is assumed that an acceptable mitigation plan can be developed and implemented.

Yellow-seed false-pimpernel, tropical saltbush and bushy knotweed are located outside the preferred location for the proposed RoW and are unlikely to be adversely affected by construction activities.

Disposal of the diluted brine solution in the Shubenacadie Estuary could adversely affect rare plants by exposing them to salt concentrations higher than their tolerance levels. The resulting osmotic stress can result in plant mortality. Plants growing within the intertidal zone of the Estuary are tolerant of saline water since they are regularly exposed to seawater. The degree of tolerance to saline water varies by species. The brine transported by the pipeline will be stored and released on the high tide in order to reduce the potential for osmotic shock. It will also be diluted with river water to reduce its salinity. These techniques will be used to maintain the salinity of the diluted brine to within the range found in the Estuary

at the point of discharge. Maintenance of brine salinity levels within the normal range of salinities found in the Estuary will prevent mortality of estuarine plants caused by osmotic stress.

6.2.5.2 Operations and Maintenance

Vegetation management required along the pipeline RoW and other Project facilities is one of the operational activities that would have the potential to cause adverse effects on uncommon and rare plants. The type of vegetation management used on the RoW will depend at least partially on the wishes of the landowner. Herbicides are likely to be used on portions of the pipeline RoW that pass through agricultural lands as part of the farming practices pursued by the landowner. It is recommended that mechanical vegetation control be used on the RoW wherever it does not contravene the wishes of the landowner. Undisturbed retrorse sedge habitat will become part of the new RoW if HDD is used to avoid the loss of this population at the eastern end of the proposed route. If this area is subject to vegetation management practices, the retrorse sedge population could be adversely affected. This area should be cordoned off to prevent the movement of Project related equipment through the habitat. This could be accomplished either by fencing the habitat or placing large rocks around the portion of the RoW bordering the retrorse sedge habitat. If it is necessary to clear trees inside the habitat, the clearing should be done using hand tools.

Provided the mitigative measures are followed, residual adverse environmental effects on vegetation are predicted to be not significant for the operations and maintenance phase of the Project.

6.2.6 Follow-up and Monitoring

In areas where pipeline route alterations will be considered (where practical) to avoid populations of rare or uncommon plant species it is recommended that supplemental rare plant surveys be conducted along the new route to determine if rare plants or other sensitive habitats are present. This information will be used to ensure that the new route does not result in more adverse effects on rare plants than the original route.

6.2.7 Summary of Residual Environmental Effects Assessment

With mitigation methods and proper scheduling, no significant adverse residual environmental effects on rare plants due to construction or operational activities are likely to occur.

6.3 Wildlife and Wildlife Habitat

6.3.1 VEC Identification

A number of wildlife species were identified in the Project area, some of which are migratory and/or species of special management concern. As all phases of Project development have the potential to affect wildlife and the habitat on which they depend.

6.3.2 Boundaries

Wildlife could occur anywhere within the Project footprint and surrounding areas; thus the spatial boundary for assessment of wildlife and habitat includes these areas.

Most bird species of the Project area are migratory. However, some species of birds are resident and do not regularly travel far from specific areas. Consequently, temporal boundaries for birds vary by species. The breeding season is generally the most critical period for birds. During the breeding season, birds are sensitive to habitat destruction and disturbance, as eggs and nestlings cannot avoid areas of disturbance and parent birds may abandon nest sites in response to disturbance.

Terrestrial herpetiles and mammals of the Project area are generally non-migratory, and undertake only seasonal movements. Therefore, species found in the Project area are likely present throughout the year.

Many species of mammals and all herpetiles become inactive for the winter months, with some species entering into hibernation. Animals that undergo extended winter sleep are sensitive to physical disturbance of habitat during the winter months, as they have limited ability to avoid disturbance and are in a state of physiological stress.

Most species of amphibians congregate, mate, and lay eggs in aquatic habitats during the spring, with eggs and larvae present in watercourses during the spring and summer months.

The *Migratory Birds Convention Act* protects all migratory bird species in Canada. The killing of migratory birds or the destruction of their eggs, or young is an offence under the *Migratory Birds Convention Act*. The Nova Scotia *Wildlife Act* and Regulations protect all non-game bird species, which are not considered pests. Non-migratory game birds, such as ruffed grouse, are protected outside of hunting seasons as defined by NSDNR. Game birds are managed by NSDNR.

Herpetiles which are hunted for food, such as snapping turtles and bullfrogs, are protected from hunting outside of hunting seasons as defined by NSDNR. Other herpetiles of no special status have no legislated protection unless they are found in a protected area such as a provincial park.

All mammal species not designated as game animals or other harvestable wildlife under the provincial *Wildlife Act* and Regulations are protected at all times of the year. Game and furbearing animals are protected outside of hunting seasons as defined by NSDNR. Harvestable mammals are managed by NSDNR.

Bird, herpetile and mammal species at risk are protected by *SARA* and the Nova Scotia *Endangered Species Act*.

Information regarding wildlife species and habitats within the Project area was derived from field surveys in 2006. Additional information was obtained from interviews with staff at NSDNR, literature and technical reports. Little information exists on the distribution and population parameters of some wildlife species in Nova Scotia, particularly small mammals including bats.

Overall, field data collected specifically in support of this assessment, existing data, and knowledge of the Study Team on environmental conditions and Project activities allow for an assessment of potential effects on wildlife and wildlife habitat with a high level of confidence.

6.3.3 Residual Environmental Effects Evaluation Criteria

SARA and the Nova Scotia *Endangered Species Act* protect species at risk. There are different levels of protection afforded a species within these Acts depending upon the species rarity ranking. For example, only those species currently listed in Schedule 1 of *SARA* are protected by that Act. Furthermore, *SARA*-listed species designated as "Species of Special Concern" are not protected by the prohibitions of Sections 32-36 of *SARA*, but do require that provincial or regional management plans be developed to protect the species within a specified timeframe. There are also several agencies that provide lists of species of conservation concern that are not protected by an Act, but that do require special consideration for the purpose of environmental assessment. As a result, several significance criteria are required to accommodate the different levels of protection afforded by these various Acts, agencies and listings.

A **significant residual adverse environmental effect** on all species listed in Schedule 1 of *SARA* as "Extirpated", "Endangered" or "Threatened" or listed by the Nova Scotia *Endangered Species Act* as "Endangered" or "Threatened" is one that results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA*, or in contravention of any of the prohibitions stated in Section 13 of the Nova Scotia *Endangered Species Act*.

A **significant residual adverse environmental effect** on species of conservation concern not protected under *SARA* or the Nova Scotia *Endangered Species Act* (*i.e.,* listed in *SARA* but not as "Extirpated", "Endangered" or "Threatened" in Schedule 1; listed as "Species of Special Concern" within Schedule 1 of *SARA*; or listed under COSEWIC as "Endangered," "Threatened" or "Special Concern;" or ranked as "S1," "S2," or "S3" by ACCDC and also (where available) ranked "red" or "yellow" by NSDNR) is:

- one that alters the terrestrial habitat within or adjacent to the Project area physically, chemically, or biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a viable population that is dependent upon that habitat such that the likelihood of the long-term survival of these rare, uncommon and/or non-secure population(s) within or adjacent to the Project area is substantially reduced as a result; and/or
- one that results in the direct mortality of individuals or communities such that the likelihood of the long term survival of these rare, uncommon and/or non-secure population(s) within or adjacent to the Project area is substantially reduced as a result; and/or
- in the case of species of special concern listed in Schedule 1 of SARA, where the Project activities are not in compliance with the objectives of management plans (developed as a result of Section 65 of SARA) that are in place at the time of relevant Project activities.

A **significant residual adverse environmental effect** on secure wildlife species (including sensitive species such as colonial nesters that are not considered rare or at risk) is:

- death or life threatening injury of wildlife species in sufficient numbers to adversely affect species populations and ecological functioning of the wildlife community; and/or
- long-term or permanent displacement of any species from preferred feeding, nesting, and rearing habitats or migratory routes.

A **positive** effect occurs when Project activities increase species populations.

6.3.4 Potential Interactions, Issues and Concerns

Construction

A number of activities (*i.e*., clearing and grubbing) associated with pipeline construction could interact with wildlife. Potential effects on wildlife during construction include habitat loss, fragmentation and noise and related disturbance due to the presence of humans.

Linear developments, like pipelines, have the potential to fragment natural habitats. Fragmentation is the partitioning of habitat into discrete units, where some mechanism (*e.g*., human presence) impedes or prevents the exchange of wildlife between habitat units. Fragmented wildlife populations have a lowered effective population number. In turn, small populations are more susceptible to decline or extirpation due to natural and anthropogenic stressors and loss of fitness potential due to genetic homogeneity. The proposed RoW will contribute to local habitat fragmentation particularly during the first few years of its existence. Initially, there will be little vegetation on the RoW, which may make it difficult for small mammals and some insects to move from one side of the RoW to the other. However, vegetation cover including tall shrub cover will be permitted to grow on the RoW providing cover that will facilitate wildlife crossing. Approximately 19 ha of the RoW passes through recent clear-cuts and active agricultural land. In these areas, the proposed RoW will not contribute substantially to habitat fragmentation since there is little difference in habitat structure between the RoW and the surrounding habitat. Human presence and noise during construction may temporarily discourage wildlife species, especially large mammals, from crossing the RoW; however, once the construction phase is over, the presence of humans and human activity is expected to return to baseline levels.

Limited direct mortality of some small wildlife, such as rodents, shrews and herpetiles, is likely to occur during construction activities. Small animals tend to stay in close proximity to cover when exposed to high noise levels, making them vulnerable to injury and death due to heavy equipment during site clearing and grading. Large and medium size mammals are unlikely to suffer direct mortality from clearing activities as they would flee the area in response to human presence and noise. Such avoidance behaviour by mammals could result in changes in normal movements, migrations and other life history processes. The impacts of such avoidance behaviour would be temporary, as mammals would likely return to adjacent habitats after construction is complete. Some wildlife, such as herpetiles, American black bear, certain bat species, and various rodents hibernate or go through prolonged periods of sleep during the winter months. An animal disturbed during periods of extended winter inactivity may die from exposure or subsequent starvation due to expenditure of energy. Therefore, wildlife species in winter sleep are sensitive to disturbance during construction activities.

Adult birds are unlikely to be killed or injured during construction activities as they would flee the area when exposed to high noise levels. Such avoidance behaviour by adult birds could result in changes in normal movements, migrations and other life history processes. The impacts of such avoidance behaviour would be temporary, as birds would likely return to adjacent habitats after construction is complete. The nesting season is generally the most critical life history stage for birds, since eggs and nestlings cannot move from a source of disturbance. Eggs and nestlings located in areas to be cleared would likely be destroyed. Potential adverse effects due to noise on bird breeding may also result from abandonment of the nest or increased rates of predation and exposure of hatchlings and eggs during temporary abandonment.

Discharge of diluted brine into the Shubenacadie and Stewiacke River estuaries could adversely affect birds by potentially altering their food supplies. The Shubenacadie Estuary is used by a number of fish-eating birds including Bald Eagles, which nest along the river and Red-breasted Mergansers which congregate in the Estuary during the winter months to feed on tomcod. If fish populations are adversely affected, these species of birds could be adversely affected. The Shubenacadie River also attracts shorebirds during late summer and fall. These birds feed on invertebrates (particularly *Corophium volutator*) in the mud along the shores of the Estuary. If the diluted brine adversely affects these invertebrates, the ability of the Estuary to provide food for these species of birds would be adversely affected (Section 6.2).

Operations and Maintenance

During the operational lifespan of the Project, periodic vegetation control along the RoW may disturb wildlife due to noise and human presence. The maintenance of the RoW throughout the life of the Project will inhibit the natural succession of habitat. Woody vegetation will be permitted to grow on the RoW but will not be allowed to become more than a few meters tall. The cleared RoW would also increase the accessibility of wildlife habitat to the general public, increasing the likelihood of continued disturbance and illegal hunting activities.

Herbicides used in vegetation control may be toxic to some wildlife species at high concentrations. Vegetation management along the RoW will be conducted mainly by mechanical means and no herbicides will be used within 30 m of a watercourse. Landowners may use herbicides as part of their agricultural operations in areas where the RoW passes through agricultural land.

6.3.5 Analysis, Mitigation and Residual Environmental Effects Prediction

This section provides an analysis of the environmental effects of the key Project-wildlife interactions by Project phase, including a discussion of the planned mitigation.

6.3.5.1 Construction

A number of activities (*i.e*., clearing and grubbing) associated with pipeline construction could interact with wildlife. Potential effects on wildlife during construction include habitat loss, fragmentation and noise and related disturbance due to the presence of humans.

Clearing and grubbing will result in the removal of trees, shrubs and other ground cover such as herbaceous plants, brush piles and dead falls that provide nesting habitat for various bird species. The effects of clearing and grubbing are most severe when these activities are conducted during the period when most bird species are breeding (predominantly from April 1 to August 15). Clearing and grubbing at this time will likely result in the direct mortality of eggs and unfledged nestlings. Clearing should be conducted during the fall and winter, which should avoid most adverse effects on nesting birds. In addition, the width of RoW cleared will be as narrow as practical to reduce the amount of lost habitat. If clearing is necessary prior to August 15, the Project area will be monitored for breeding activities no more than one week prior to beginning Project activities. Activities which may impact the young will not occur within a 50 m buffer zone surrounding the nest.

It is acknowledged that there are some bird species such as White-winged Crossbills and Red Crossbills that nest during the winter months. Any additional mitigative measures to address these

species or ground nesting species that could be affected in the RoW after it is cleared, will be undertaken, as feasible, at the request of the relevant regulatory authorities.

Breeding bird surveys identified three “yellow” listed species as being present in the proposed RoW including Boreal Chickadee, Olive-sided Flycatcher and Barn Swallow. There were also a number of raptor species encountered including two species, Broad-winged Hawk and Osprey, for which nests were found in relatively close proximity to the RoW. Raptor species are typically sensitive to disturbance around their nest sites and are easily identified by the general public as either hawks or owls. A Great Blue Heron rookery was also encountered during the field survey. Great Blue Herons are also sensitive to human activities around their nests. Great Blue Herons nest communally so there is high potential for disturbance events to affect the success of a number of nests rather than just one.

No Boreal Chickadee nests were encountered during the field survey; however, suitable nesting habitat was present. This species is relatively tolerant of human activities; however, it is sensitive to loss of nesting and winter shelter sites. Boreal Chickadees nest in tree cavities. This species does not migrate and roosts in tree cavities during the winter months to provide thermal protection on cold nights. Loss of mature coniferous and mixedwood forest results in the loss of large trees that are most likely to contain useable cavities. Boreal Chickadees can make use of cavities in small trees but the probability of finding cavities in younger trees is much lower than in older larger trees. Clearing of the RoW in mature coniferous and mixedwood forest will result in the loss of trees containing cavities. The potential adverse effects on Olive-sided Flycatchers are not expected to be severe. There will be no loss of breeding habitat since the wetlands where both Olive-sided Flycatchers were heard will not be disturbed. The RoW will be cleared during the fall and winter when Olive-sided Flycatchers are not present. If clearing is necessary prior to August 15, the Project area will be monitored for breeding activities no more than one week prior to beginning Project activities. Activities which may impact the young will not occur within a 50 m buffer zone surrounding the nest. Olive-sided Flycatchers may be exposed to noise when the pipeline is laid following clearing. The small stream that connects the two wetlands where Olive-sided Flycatchers were detected will be crossed using HDD to minimize disturbance of stream and wetland habitat. The HDD will take up to a few days to complete during which there will be a static source of noise that could disturb nesting Olive-sided Flycatchers. HDD at this site will not be conducted during the period from April 1 to August 31. If clearing is necessary prior to August, the Project area will be monitored for breeding activities no more than one week prior to beginning Project activities. Activities which may impact the young will not occur within a 50 m buffer zone surrounding the nest.

No mitigation is recommended for Barn Swallow. This species is highly tolerant of human activities and the RoW will not result in the loss of buildings or other structures that could provide potential nesting sites for this species.

Generally, a buffer zone of 100 m is adequate to protect Osprey nests from human activities. At the Osprey nest observed near the proposed RoW, the adult birds became anxious when observed approached within 200 m of the nest. It is therefore recommended that no activities be conducted within 200 m of the nest during the period from April 1 to July 30 (Figure 5.2). If clearing is necessary during this period, the Project area will be monitored for breeding activities no more than one week prior to beginning Project activities. Activities which may impact the young will not occur within a 50 m buffer zone surrounding the nest.

No mitigation is required for the Bald Eagle nest located on the shore of the Shubenacadie River. This nest is situated approximately 1.2 km north of the brine storage pond at Fort Ellis. At this distance, it is unlikely that construction activities would disturb nesting Bald Eagles at this site.

No specific mitigation is proposed for the Broad-winged Hawk nest. This species rarely uses the same nest twice as it is not possible to predict where this species will be nesting in the future. Clearing of the RoW during the winter months will prevent the direct loss of an active nest. Construction activities could disturb a nest located adjacent to the RoW; however, unless the nest is located near an HDD site, the duration of construction activity near the nest site should be brief. If during the construction phase of the Project these species are encountered by environmental inspectors and display behaviours that suggest the presence of a nest, a skilled birder or ornithologist would be called to confirm the presence of a nest and prescribe appropriate mitigation to prevent the loss of eggs or young as a result of construction activity. This would also apply to the suspected Merlin nest located near Fort Ellis as well as other raptor nests that might be discovered along the proposed pipeline RoW.

The Great Blue Heron rookery is located approximately 500 m south of the proposed pipeline RoW. NSDNR recommends the use of a 400 m buffer zone around Great Blue Heron rookeries to protect them from disturbance (Figure 5.2). Prior to the commencement of construction, in late summer (no sooner than late August), a field survey will be conducted to determine the exact location and size of the colony. The following information will be sent to the Canadian Wildlife Service (CWS): a map showing the delineated colony, GPS coordinates, number of nests observed, and number of nests that appear to have been used. In order to avoid attracting people to this sensitive site, the specific location data will not be generally available. In addition to the general buffer (*i.e.*, NSDNR 400 m) from the edge of a heron colony from April through mid-August, no activities with a high disturbance factor (*e.g.*, blasting, drilling) will occur within a one-kilometer buffer during this period. Also, no activities that would require the removal of trees will take place within the 400 m buffer regardless of the time of year. Activities which may impact the young will not occur within the buffer zone surrounding the nest. The field survey may be conducted by helicopter to search for the rookeries. Great Blue Herons construct relatively large stick nests and their guano kills the trees they nest in. As such, the rookeries (particularly larger ones) are usually easily spotted from the air.

There will be habitat loss and sensory disturbance associated with noise during Project construction as well as the potential mortality of small mammals and herpetiles. Two sensitive bat species, the little brown bat and red bat are likely present along the RoW during the spring, summer and early fall. At this time of the year, little brown bats are not particularly sensitive to human activities. The field surveys suggest that it is unlikely that there are bat hibernacula sites on or near the proposed pipeline RoW. In addition, overburden thickness is such that no blasting will be required reducing the potential to disturb hibernating bats.

It is not known whether or not migratory bats such as the red or hoary bat are present in the area. The distribution and abundance of these species is poorly understood in Nova Scotia. There is some potential for disruption of hoary and red bat breeding activity as a result of disturbance of potential red or hoary bat nursery sites in woodland adjacent to the RoW. These species would be most susceptible to sensory disturbance during the period from mid-June to August when young bats are present. These species are probably not particularly sensitive to human activities and red bats in particular are often observed in towns where they feed on insects attracted to street lights. Given the fact that

construction activity will occur in one location only for a short time, it is unlikely that this activity would have a significant adverse effect on these species.

Moose have been sporadically observed in the Project area; although, no evidence of their presence was observed during the field surveys. This would suggest that the Project area is not important moose habitat. Moose that enter this area may be temporarily disturbed during construction due to noise and human presence. The construction of the pipeline will contribute to habitat fragmentation particularly during the first few years following construction of the pipeline when there is no tall vegetation on the RoW. Linear developments, namely highways, have been implicated as a contributing factor in the fragmentation of the mainland moose population into distinct units, rendering such fragmented populations susceptible to pathogens and loss of genetic diversity (Snaith 2002). However, in the case of pipeline corridors where there is no ongoing human presence and noise, moose would likely cross such areas and perhaps use them as migratory corridors and for browsing.

Direct mortality of hibernating small mammals and herpetiles over-wintering on-land may occur during clearing of the site. However, the area to be cleared will be minimized, thereby decreasing the likelihood of disturbing over-wintering animals. No evidence of American black bear was recorded during the field survey although this species has been occasionally observed in the general area. Abundant blowdowns along the central portion of the proposed pipeline RoW could provide suitable hibernation sites for black bears. In the unlikely case of disturbing a bear during winter sleep, NSDNR will be contacted.

The majority of amphibians and freshwater turtles hibernate in aquatic habitats. Watercourse crossings will be made using HDD which will greatly reduce the potential for overwintering amphibians and turtles to be killed by construction activity. Although no wood turtles were noted during the field surveys, this species has been reported on Big Meadow Brook. As a precautionary measure, it is best to proceed with the assumption that wood turtles are present within the Project area, and may be encountered. If wood turtles are found during construction, they will be picked up and moved just off site, along the same habitat corridor in the direction of travel the turtle was originally oriented. A New York State study (Carroll and Ehrenfeld 1978) showed that 84% of wood turtles displaced less than two kilometres overland were able to return to their home range. Moving the wood turtles 100 m to 400 m from the original site where they were found should not be unduly disruptive to them. In addition, construction crews will be provided with environmental awareness training and will be educated on the protection of wildlife, including herpetiles.

Discharging of diluted brine into the Shubenacadie Estuary could adversely affect populations of fish and invertebrates such as *Corophium volutator* (Section 6.1) that provide important sources of food for birds such as Bald Eagles, waterfowl and various shorebirds and mammals such as river otter and mink. The brine solution will be diluted and discharged around high tide to minimize the difference in salinity between the effluent and the receiving water body and to maximize the potential for mixing. Modeling results indicate that the salinity of the diluted brine discharged into the Estuary will be within the range of salinities that are normally experienced in the Estuary. This will greatly reduce the potential for adverse effects on estuarine fishes and invertebrates and any secondary adverse effects on wildlife that feed on these organisms.

Trench inspections for trapped fauna will be conducted at the beginning of each working day. If an animal is trapped in the trench, NSDNR will be contacted.

With mitigation methods and proper scheduling, no significant adverse residual environmental effects on wildlife and wildlife habitat due to construction activities are likely to occur.

6.3.5.2 Operations and Maintenance

Herbicides are likely to be used on portions of the pipeline RoW that pass through agricultural lands as part of the farming practices pursued by the landowner. However, mechanical clearing will be the preferred vegetation control method during RoW maintenance. RoW clearing should be prioritized to occur outside of the breeding season for most species of birds (April 1 to August 15). If clearing is necessary prior to August 15, the Project area will be monitored for breeding activities no more than one week prior to beginning Project activities. Activities which may impact the young will not occur within a 50 m buffer zone surrounding the nest.

In areas where forestry roads intersect the RoW, it is recommended that locked gates be placed along the RoW, where feasible and in accordance with the wishes of landowners. This would impede vehicular traffic (snow-mobiles, ATVs, off-road vehicles), and decrease potential disturbance to wildlife along the RoW. Limiting human presence along the RoW would also decrease the likelihood of high risk wildlife encounters and illegal hunting activities.

With mitigation methods, no significant adverse residual environmental effects on wildlife and wildlife habitat due to pipeline operations and maintenance are likely to occur.

6.3.6 Follow-up and Monitoring

It is recommended that a survey be conducted to determine the exact location of the Great Blue Heron rookery near Fort Ellis. In lieu of this survey, an extended buffer zone (650 m in radius) would be established around the suspected rookery site during the breeding period to take into consideration potential underestimation of the distance between the rookery and the proposed RoW.

6.3.7 Summary of Residual Environmental Effects Assessment

With mitigation methods and proper scheduling, no significant adverse residual environmental effects on wildlife and wildlife habitat due to construction or operational activities are likely to occur.

6.4 Land and Resource Use

6.4.1 VSC Identification

Land and Resource Use is a VSC because of its importance to socioeconomic development. Land and Resource Use includes all existing residential, industrial and commercial land use, as well as settlement areas, lands used for recreation, agriculture and resource use (*e.g.*, forestry, mineral exploration), and other areas of special community or social value. The nature and extent of developed lands, areas used for recreation, and other areas of special value are important determinants of the socioeconomic character of a community. Recreational fisheries are assessed in Section 6.6. Traditional Land and Resource Use addresses Aboriginal land and resource use and is presented in Section 6.7.

6.4.2 Boundaries

Spatial boundaries include the lands in the vicinity of the proposed underground storage facility, a 12-km RoW (20 m wide), and intake and discharge areas. The boundaries also extend to all lands outside the corridor that could potentially be affected by the Project during construction and operation.

Temporal boundaries of the Project effects on land use include the construction and operation phases of the Project. Some land uses are seasonal in nature (*e.g.,* recreational) and/or may have seasonal sensitivities (*e.g.,* residential, agricultural) with respect to Project activities, which should be considered in Project planning.

The Project site is within the Municipality of the County of Colchester and is not covered by a Municipal Planning Strategy. There is currently no land use zoning or development plan in place that applies to the Project site or adjacent lands.

The assessment of potential interactions of the Project on land and resource use is based on existing documented information, personal communications (via telephone and email) with key informants, and a windshield survey of the area. Key informants included representatives from:

- Municipality of the County of Colchester;
- Town of Stewiacke;
- Colchester Regional Development Agency; and
- Nova Scotia Department of Natural Resources.

Discussions were also undertaken with representatives from various recreational and tourism groups.

6.4.3 Residual Environmental Effects Evaluation Criteria

A **significant adverse environmental effect** on land and resource use (*i.e.,* residential, industrial, commercial, forestry, mining, agricultural and/or recreational land use) is one where the proposed use of land for the Project is not compatible with adjacent land use activities and the proposed use of land for the Project will create a change or disruption that restricts or degrades present land uses such that the activities cannot continue to be undertaken at current or recent levels for extended periods of time and is not compensated.

A **positive** effect occurs when the Project results in enhanced land and resource use for residential, commercial, forestry, agricultural and/or recreational uses.

6.4.4 Potential Interactions, Issues and Concerns

Potential interactions between the Project and land and resource use relate primarily to changes in land use as a result of the Project. Although most of these potential effects are limited to the construction phase, there are some effects such as restrictions on future land use within the RoW that extend for the life of the Project.

Potential effects may include the following:

- minor air and noise emissions during construction;
- short-term traffic increase during construction;
- permanent loss of merchantable forest resource as a result of construction;
- temporary loss of agricultural land and production as a result of construction;
- short-term reduction in access to hunting, fishing, ATV/snowmobile use during construction;
- restrictions on permissible uses of RoW lands during operations; and
- potential increase in ATV/snowmobile trespass along the RoW during operations.

As discussed in Section 2.4.1, air emissions will include dust and exhaust emissions during construction. Control measures, such as use of dust suppression techniques, will be used in construction zones as required to minimize the impacts from fugitive dust. Routine inspection and maintenance of construction equipment will minimize exhaust fumes. All air emissions will be maintained within the Nova Scotia Air Quality Regulations (*Environment Act*) and *Canadian Environmental Protection Act* Ambient Air Quality Objectives. Air quality effects on land use are therefore not considered further in this analysis. Noise emissions will not exceed the provincial guidelines (refer to Section 2.4.2) and are not expected to affect land use. Noise emissions are also therefore not discussed further in this analysis.

6.4.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.4.5.1 Construction

Residential, Industrial and Commercial Land Uses

It is not anticipated that any existing residential housing will be directly affected by the Project (*i.e.,* no houses will require relocation). Landowners along the RoW will have land agreements negotiated with the Proponent which will serve to secure the easement for the Project and compensate landowners for any loss of use. The negotiated agreement will also include land use/monitoring conditions for the landowner and Alton.

Other potential effects may include temporary or limited access to residential areas during pipeline installation. There is predicted to be a short-term increase in traffic in residential areas for a portion of the construction phase. Alton and its construction contractors will work to minimize any traffic interruptions and ensure that traffic continuity is maintained. Increases in traffic are most likely to be noticeable in the area of the intake and discharge systems (*e.g.,* Fort Ellis and Riverside Roads) where traffic levels are currently very low. However, this traffic increase will be temporary and is likely to interact with only a small portion of the population due to its isolated location.

There is no predicted interaction with industrial and commercial land uses during construction. As noted in Section 5.7, commercial land uses in the immediate study area consist of home-based service businesses which do not generate a great deal of dedicated traffic. Any minor disruptions due to short-term increases or interruptions of traffic flow will be of relatively short duration.

Agriculture and Natural Resource Use

The proposed RoW crosses several properties currently used for agricultural purposes. It is estimated that approximately 19 ha of agricultural land will be affected by the 20 m RoW. Areas with crop yield that are directly affected by construction activities may experience reduced crop yields for a brief period after Project construction. Agricultural landowners will be compensated by Alton to mitigate this loss.

Appropriate soil management procedures will be implemented to minimize effects on agricultural soils. In particular, the EPP will include procedures to address the following soil management issues:

- removal (stripping) and stock piling top soil prior to construction;
- measures to avoid mixing topsoil with subsoil;
- restoration of the RoW to avoid erosion, and restore soil productivity;
- restoration of soil fertility; and
- relief of compaction.

Alton will work with farmers to monitor any residual crop loss and if required, implement additional mitigation in order to return the land to its pre-construction capacity. Farmers will be compensated for reduced crop yields during this post-construction period as necessary. Where drainage tiles and erosion control devices or measures have been used, these will be replaced by the Proponent following construction as per individual landowner agreements.

During the open house on November 22, 2006, a landowner expressed concern with respect to salination of fields due to flooding of pasture downstream from the discharge area due to concentrated brine discharge. As described in Section 2.1, the brine discharge system is designed to discharge concentrations less than 25 ppt, equivalent to natural conditions.

Approximately 32 ha of forested land will be directly affected by the 20 m RoW. As the RoW will be relatively small compared to the overall forest resources available in Colchester County, it is not anticipated that the Project will result in a significant decrease in the merchantable forest resources and forest resource managers will be able to meet the present and future forestry needs in this area. Alton will work with forestry resource owners to salvage merchantable timber that may be affected by Project construction. As with agricultural soils, the EPP will include procedures to minimize any loss of forest soil productivity due to Project construction.

Tourism and Recreation

Construction of the Project has the potential to interact with recreational land use within the RoW by limiting access where construction activities are occurring. However, these effects are predicted to be minimal since there are no formal trails within the RoW and recreational facilities, including the Stewiacke River Park and ballfields, are located several hundred metres from the RoW. Signage and fencing will be installed around any open excavation to protect public safety. As stated in Section 5.7, the Shubenacadie River tour operators do not extend their operations as far upstream as the Project area and there is no predicted interaction with their operations.

It is not anticipated that water intake/discharge structures will intrude into the Estuary to an extent that could impede navigation. However, once the Project design is finalized, Alton will consult with

Transport Canada to determine if an application under the *Navigable Waters Protection Act* is required. Signage warning boaters and fishers of work in progress in the Project area will be necessary.

6.4.5.2 Operation and Maintenance

The operation and maintenance phase of the Project may have an adverse effect on Land and Resource Use as a result of the limits that the presence of the pipelines may have on adjacent or proposed future activities in proximity to the pipeline for the life of the Project. Regular maintenance along the RoW (*e.g.,* mowing) and maintenance of the pipelines themselves are anticipated to result in short-term, minor effects on Land and Resource Use.

Residential, Industrial and Commercial Land Use

Prior to construction, Alton will negotiate the easement for the pipelines with each affected landowner. These negotiations will include a covenant which places limits on permissible uses of the easement lands associated with the pipelines. For example, the pipeline easement will prohibit landowners from building permanent structures on the RoW.

The presence of the pipelines will not affect current commercial and industrial land use but could affect future development that involves excavation using mechanical equipment or explosives within 30 m of the pipelines. At this time, however, there are no known commercial/industrial developments planned to occur in the immediate Project area.

There is the potential that the Project itself may enhance industrial and commercial development in the larger study area (*e.g.,* Stewiacke, Colchester County) associated with the storage and potential increased availability of natural gas in the area. Section 6.5 of the EA Report addresses this issue of potential economic spin-offs.

Agriculture and Natural Resource Use

Project interactions with agricultural land use during the operations and maintenance phase are predicted to be limited since the presence of the pipeline will be designed to accommodate identified agricultural activities after construction is complete.

The operations and maintenance phase of the Project will not result in environmental effects on natural resource use (*i.e.,* forestry) beyond those resulting from the construction phase. However, as discussed in Section 6.4.5.1, loss of merchantable timber during pipeline construction will be permanent. Forestry use on the pipeline easement during Project operations would be limited to low growing trees (*e.g.,* Christmas tree plantation) as per the easement covenant that will be negotiated between Alton and forestry resource owners.

Tourism and Recreation

Although considered trespass, the existence of the RoW may increase ATV/snowmobile traffic along the RoW. Signage, natural barriers and fencing will be used as per landowner agreements with Alton to minimize trespassing along the RoW. The intake and discharge pipes will be buried and will not interfere with navigation along the Shubenacadie River. There is not likely to be any significant adverse effects on tourism and recreation as a result of Project operations.

6.4.6 Monitoring and Follow-up

Land Agents working on behalf of Alton will monitor construction to ensure commitments made in landowner agreements are upheld by the construction contractor. In addition, within the Environmental Management Plan (EMP), Alton will develop an Issues Resolution System which will include a procedure to deal with Project-related complaints/issues from landowners and/or the public. This procedure will ensure complaints are recorded, tracked and resolved in a timely manner. This procedure will also monitor commitments made to landowners. Specific issues identified through this process may require follow-up and/or monitoring.

6.4.7 Summary of Residual Environmental Effects Assessment

Assuming the implementation (including compensation) of the recommended mitigation measures, there is not likely to be any significant adverse environmental effects on Land and Resource Use as a result of the Project.

6.5 Labour and Economy

6.5.1 VSC Identification

Labour and Economy is a VSC because of the potential interactions with Project activities, during both the construction and operation phases of the Project. Project employment and expenditures will result in direct and indirect economic impacts in the local area, as well as more broadly within the Province of Nova Scotia, as a result of the construction of the pipeline and surface facilities and operation of a gas storage facility. This VSC is closely linked to Land and Resource Use (Section 6.4).

6.5.2 Boundaries

Spatial boundaries for the assessment of potential effects of the Project on Labour and Economy include those areas where Project activities could create direct or indirect changes in employment, income, economic output and labour supply. The Project's effects can be expected to be most closely linked to Colchester County, particularly the Stewiacke area, but the Province of Nova Scotia, as a whole, will also be affected.

Temporal boundaries of the Project effects include the construction and operation phases of the Project, with an emphasis on the construction period (as per the schedule in Figure 2.5).

The Project site is within the Municipality of the County of Colchester. The Colchester Regional Development Agency (CoRDA) is the organization that has been given the mandate for economic development by the Town of Truro, the Town of Stewiacke and the Municipality of the County of Colchester. CoRDA works with local communities to provide community economic development services, business development services and strategic plans. The Province of Nova Scotia has primary responsibility with respect to the management of economic development throughout the province.

The assessment of potential interactions of the Project on Labour and Economy is based on existing documented information and personal communications (via telephone and email) with representatives from:

- Municipality of the County of Colchester;
- Town of Stewiacke; and
- Colchester Regional Development Agency.

6.5.3 Residual Environmental Effects Evaluation Criteria

A **significant adverse environmental effect** on Labour and Economy is one in which the Project induces substantive adverse changes in regional employment and/or regional economies. This includes consideration of changes in revenues to or the profitability of existing businesses, tourist attractions, and agriculture and forestry operations, where the Project results in an extended (more than seven consecutive days) temporary loss of access to or a long-term sizable decrease in business revenues or profitability.

A **positive** effect occurs when the Project results in enhanced changes in regional employment and/or regional economies.

6.5.4 Potential Interactions, Issues and Concerns

Potential interactions between the Project and Labour and Economy relate primarily to:

- generation of employment and income;
- effects on the labour supply because of the increase in the demand for labour generated by the Project;
- adverse effects due to the disruption of existing businesses and industries (*e.g.,* forestry, agriculture) during construction; and
- potential creation of local business opportunities through the improved availability/accessibility of natural gas to rural Nova Scotia.

Effects on existing industries during construction are discussed in Section 6.4, Land and Resource Use and are not likely to be significant.

6.5.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.5.5.1 Construction

As discussed in Section 2.3, it is anticipated that, on average, approximately 25 full-time equivalent positions will be created during the construction of brining facilities, installation of water pipelines and drilling of four cavern wells. Over this construction period (as per the schedule in Figure 2.5), these numbers could peak to approximately 38 positions.

During construction of the gas storage surface facilities and pipelines, approximately 20 full-time equivalent positions will be created on average over the construction period (see Figure 2.5). At the

peak of this construction phase, the number employed will reach approximately 25. The primary skills required for the work include truck drivers, concrete trades, equipment operators, piping trade, industrial welders, surveyors and general labourers. Alton will attempt to source qualified labour locally (*i.e.,* within Colchester County), although the extent to which this can occur will depend somewhat on the hiring practices of the contractors and businesses used during construction.

Employment directly and indirectly associated with the Project will generate income within the County of Colchester and more broadly within the Province of Nova Scotia. Construction expenditures will have positive impacts on the local economy. Total expenditures for the Project, including start of construction up to the handling of first gas, are estimated at approximately $60 million, which will result in a direct and indirect impact on provincial economic output of approximately $92 million and a GDP impact (value-added) of $25 million (estimated from 2003 Statistics Canada input-output model multipliers). For Canada as a whole, the impacts on economic output will be approximately $121 million, with a GDP impact of $40 million. These estimates will vary in accordance with the proportions of goods and services that can be sourced provincially and nationally.

There is a total workforce of approximately 24,380 in Colchester County (Statistics Canada 2002). Of these, approximately 4990 (20%) are experienced in the construction and manufacturing industries. Given the existence of an experienced labour force in the region relative to the demands of the Project during construction, and in consideration of the level of unemployment in the region, there are no anticipated adverse effects on the labour supply. That is, there is not expected to be a shortage of labour as a result of the Project.

Alton intends to communicate labour and material requirements to labour unions and local suppliers in advance of tenders to allow the local markets time to prepare bids and adjust the labour force and training requirements where practical. This communication may include vendor information sessions.

There is not likely to be any significant adverse effects on Labour and Economy as a result of Project construction. There is, however, predicted to be a positive effect as a result of direct and indirect employment and income generated by construction.

6.5.5.2 Operation and Maintenance

During gas storage operation, it is anticipated that five to ten full-time equivalent positions will be required. This will include two or three office staff (to be located in Halifax), two full time gas plant technicians, and a plant engineer.

In addition to direct employment, the Project is expected to contribute to the community by:

- bringing gas closer to the communities of Alton, Brookfield, Stewiacke, and Truro through the development of a gas pipeline to the Alton facility;
- decreasing gas price volatility for Nova Scotia gas customers;
- decreasing gas price volatility and hence power price volatility for natural gas fired power generation;
- to the extent that stable gas prices result in greater gas fired power generation and hence less coal fired generation, a potential reduction in green house gas emissions;
- increasing regional security of supply levels;

- contributing to the tax base (income, property, and sales);
- allowing for the potential of developing other energy-related projects as a result of storage; and
- contributing to the overall economic growth of the community.

Local government and business development authorities are generally supportive of this Project as they believe the Project may help attract new businesses (S. Dorey, Town of Stewiacke, pers. comm. 2006; R. Smith, CoRDA, pers. comm., 2007). In particular, the proximity of the Project to the proposed Stewiacke Business Park may enhance the selling features for industrial development in this area. The Project may also indirectly facilitate the distribution and supply of natural gas to the Truro area where companies have expressed desire to use natural gas (R. Smith, CoRDA, pers. comm. 2007).

The operation of the Project is compatible with objectives in the Regional Economic Plan and is not expected to have any adverse effects on existing industries in the area. There is, however, predicted to be a positive effect on Labour and Economy as a result of Project operations.

6.5.6 Follow-up and Monitoring

No monitoring or follow-up is recommended with respect to the effects of the Project on Labour and Economy.

6.5.7 Summary of Residual Environmental Effects Assessment

The Project is predicted to result in direct and indirect benefits to the local community as well as to the Province. There is, therefore, predicted to be a positive effect on Labour and Economy as a result of the Project.

6.6 Fisheries Resources

6.6.1 VSC Identification

Fisheries Resources are considered a VSC due to their contribution to the local economy and importance as a socio-cultural activity. Commercial and recreational fisheries are considered in this assessment. Aboriginal fisheries are discussed separately in Sections 5.10 and 6.7. Interaction between the Project and fisheries relate mainly to the potential effects on fish and fish habitat due to diluted brine discharge, water withdrawal and habitat effects. The assessment of Project impacts on fish and fish habitat are described in detail in Section 6.1.

6.6.2 Boundaries

For commercial fisheries, the assessment considers the gill-net fishery for gaspereau that occurs in the Estuary in the vicinity of the Project area. Trap-fisheries for gaspereau occur further upstream in freshwater and these areas will not be influenced by Project discharges or any other activities; thus are not considered further.

The assessment considers recreational fishing activities that may occur in the Estuary. The majority of recreational fishing activity for targeted species such as American shad, brook trout, striped bass, and

various freshwater fish species occurs further upstream in freshwater habitats along the Stewiacke and Shubenacadie Rivers.

The temporal boundaries for fisheries resources have been developed in consideration of the time periods of construction and maintenance. The temporal boundaries also consider time periods when fisheries are most active in the Project area (*e.g.*, during fishing seasons). Biologically sensitive time periods (*e.g.,* spawning) for fish and fish habitat are discussed in Section 5.4.

The protection of fishing resources generally falls under the federal *Fisheries Act* as protecting fish and fish habitat ultimately includes fisheries resources. Fisheries resources are also protected by legislated fishing quotas, fishing seasons and gear limitations. Commercial fisheries are the responsibility of DFO, whereas recreational fishing in Nova Scotia is administered primarily by NSDNR.

Published literature and personal communications with fishers were the primary sources of information used to support this assessment of Project related fisheries activities.

6.6.3 Residual Environmental Effects Evaluation Criteria

A **significant adverse environmental effect** on fisheries resources is a Project related, uncompensated reduction in the incomes of commercial fishers or fishing profitability as a result of effects on target fish populations, damage to fishing gear or vessels, or loss of access to fishing grounds or a Project related reduction in recreational fishery resources, differentiated from declines attributable to natural variation or overfishing.

A **positive** effect on fisheries resources is one that enhances incomes or profitability of commercial fisheries or aquaculture operations, or that enhances the stocks of recreational fisheries resources.

6.6.4 Potential Interactions, Issues and Concerns

Potential interactions between the Project and recreational and commercial fisheries relate primarily to effects on exploited fish populations. There is also concern over Project interactions with potential short-term exclusion of recreational fishers in areas where HDD is taking place. Specifically, potential interactions between the Project and fisheries relate primarily to impacts on exploited fish populations caused by diluted brine discharge, water withdrawal and/or habitat alteration.

Gear damage or loss and exclusion from commercial fishing areas is unlikely given that Project facilities will be located along the banks of the Estuary.

6.6.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.6.5.1 Construction

Recreational fisheries may occur in streams along the pipeline route. All pipeline crossings will be HDD under watercourses (if technically feasible). Riparian vegetation along stream crossings will be maintained during HDD wherever feasible. No interaction is therefore expected between Project construction and operation and freshwater resources along the pipeline route. Prior to HDD activities, a geotechnical survey will be carried out to determine if HDD is technically feasible. If HDD is not practical given the underlying geology, alternative stream crossing methods will be developed in

consultation with DFO and NSEL and supporting work will include detailed fish habitat assessments, stream specific mitigation, sediment control plans and follow-up monitoring. HDD could exclude fishers from a very small area of stream for a limited amount of time (*i.e.,* one to two days), but is thus not predicted to have a significant adverse effect on recreational fishing.

Discharge of diluted brine, water withdrawal and habitat alteration could have effects on fish populations and other ecosystem components of the Estuary. However, as explained in Section 6.1, no significant adverse effects are expected on fish or fish habitat due to construction of the Project and thus no significant effects on fisheries on exploited fish populations are predicted.

Commercial fishing in the vicinity of the Project is limited to a seasonal gillnet fishery directed at gaspereau. Based on current design of water withdrawal and discharge facilities, there will be minimal impingement of Project-related structures into the Estuary and thus interactions with fishing gear and vessels are not expected. Potential requirements under the *Navigable Waters Protection Act* will be made upon final design of facilities and in consultation with Transport Canada. Any potential for impediment to navigation (including fishing) will be addressed as required by Transport Canada including signage, lights and other warnings.

Commercial fishers will be consulted prior to Project construction to ensure that activities that may interact with fishing activities are scheduled and conducted in such a manner as to minimize the potential and severity of interaction.

Recreational fishing is a popular activity along the Shubenacadie and Stewiacke Rivers; however, it appears that comparatively less recreational fishing occurs in the Estuary near the Project. A small area of Estuary bank within the Project property will be off-limits to recreational shore-based fishers due to safety and liability concerns. This off-limit area will be fenced. However, the area is small in comparison to the total amount of Estuary bank available for fishing activities and intense recreational fisheries are not known to occur within or near the Project footprint. Therefore, no significant effects due to exclusion of recreational fishers are predicted.

In summary, no significant adverse effects are predicted on fisheries due to construction of the Project.

6.6.5.2 Operation and Maintenance

Routine operation and maintenance activities are unlikely to interact with fisheries resources in any substantial way since there is no invasive activity in watercourses along the pipeline route and few in the Estuary during routine operations and maintenance. Vegetation management along the RoW will be conducted mainly by mechanical means and no herbicides will be used within 30 m of a watercourse. Herbicides are likely to be used on portions of the pipeline RoW that pass through agricultural lands as part of the farming practices pursued by the landowner. As described in Section 2.0, there will be occasional hydrostatic testing of the caverns using estuarine water. Water withdrawal and discharge facilities used during cavern development will be used for the withdrawal and discharge of hydrostatic test waters and hydrostatic test water will be discharged into the Estuary. The effects of water withdrawal and discharge of hydrostatic test waters on fisheries relate mainly to potential effects on fish and fish habitat, which are described in Section 6.1.

Project facilities associated with water withdrawal and discharge will remain throughout the operational life of the Project. Therefore, a small area of Estuary bank within the Project property will be off-limits

to recreational shore-based fishers due to safety and liability concerns. This off-limit area will be fenced. However, the area is small in comparison to the total amount of Estuary bank available for fishing activities and intense recreational fisheries are not known to occur within or near the Project footprint. Therefore, no significant effects due to exclusion of recreational fishers are predicted.

In summary, no significant adverse effects are predicted on recreational or commercial fisheries due to operation and maintenance of the Project.

6.6.6 Follow-up and Monitoring

Fishers will be consulted prior to Project construction to ensure that activities that may interact with fishing activities are scheduled and conducted in such a manner as to minimize the potential and severity of interaction. No other monitoring or follow-up specific to fisheries is proposed; however, a variety of monitoring and follow-up related to fish and fish habitat will be conducted and are described in Section 6.1.

6.6.7 Summary of Residual Environmental Effects Assessment

The residual environmental effects on fisheries are considered not significant for all Project phases.

6.7 Traditional Land and Resource Use

6.7.1 Introduction

The Proponent commissioned a Mi'kmaq Ecological Knowledge Study (MEKS) to assess the potential impacts of the proposed Project on current uses of the area for traditional purposes by members of the Mi'kmaq community (Appendix J). The purpose of the MEKS is to:

- determine historic and current Mi'kmaq land and resource use in the Project area;
- provide an inventory of plants of significance to the Mi'kmaq in the Project area;
- provide an analysis of potential impacts of the Project on Mi'kmaq land and resource use; and
- provide recommendations for further action or mitigation.

This information will be used to assess any interactions that may occur between Project activities and Mi'kmaq traditional resource use in the Project area.

6.7.2 Scope and Objective

The objective of the MEKS is to identify and gather Mi'kmaq Ecological Knowledge with respect to traditional and current land and resource use within the Project area. The MEKS study area includes the areas of land where the underground storage facility is to be formed, near Alton, Nova Scotia, and the 12 km proposed underground pipeline to the Shubenacadie River. It should be noted that the location intake and discharge systems evaluated in the MKS was further upstream (near the junction of the Stewiacke and Shubenacadie Rivers) than that currently proposed.

In addition, the study area includes traditional use activities that occur in a 10 km buffer zone surrounding the Project area.[1]

Information was gathered by three means:

- literature and archival research;
- interviews; and
- field sampling.

For the literature and archival research, various archival documents and published works were reviewed for information regarding the past or present Mi'kmaq occupation of the study area. Reviewed documents included census records, colonial government records, and published books.

For the interviews, an initial list of potential Mi'kmaq interviewees was developed and those were targeted for interviews. Numerous interviews were undertaken with individuals from the Mi'kmaq communities of Millbrook and Indian Brook. Interviewees were shown maps of the study area and asked various questions regarding their Mi'kmaq traditional use activities, including where they undertook those activities, when they undertook them, and what type of resource they utilized.

Site visits were undertaken with two Mi'kmaq Ecological Knowledge holders from the Indian Brook First Nation community at the proposed underground storage facility as well as at the site of water intake and diluted brine discharge at the Shubenacadie River. This provided the opportunity for further identification of traditional use activities occurring in the Project area.

6.7.3 Potential Interactions, Issues and Concerns

From the data gathered, it is evident that Mi'kmaq traditional use activities are undertaken in the vicinity of the Project area, most substantially in the past, but they continue to be practiced throughout the study area. The most significant traditional use activities that occur within the study area involve food resources, such as hunting and fishing, as well as several areas used for gathering medicinal and/or spiritual plant resources.

Fishing

Data suggest that fishing is the most significant traditional use activity that continues to occur throughout the study area. Many species are harvested, but the most common are brook trout, striped bass, and eel. Fishing for Atlantic salmon occurred in the past when this species was more common.

The most utilized waterway is the Shubenacadie River, which Mi'kmaq currently fish brook trout, striped bass, eel, as well as shad, pickerel, perch, and smelts. Another frequently used waterway is the Stewiacke River, where Mi'kmaq fish numerous species of fish. Finally, numerous small waterways that intersect the proposed pipeline are used to a lesser degree. For a map of areas that are fished by members of the Mi'kmaq community, refer to the MEKS in Appendix J.

[1] At the time of the MEKS, the Project design included an additional RoW branch from the Shubenacadie River. The current design does not include this part of the RoW. Nevertheless, the current Project components are within the MEKS study boundaries.

Hunting

The resource that is most frequently harvested by Mi'kmaq throughout the study area is deer, which is harvested in all areas. The community of Indian Brook and its surrounding land is by far the most utilized area Mi'kmaq use to hunt deer. Data identifies no less than 150 incidents of deer hunting in the Indian Brook area. Data also shows at least 15 sites and 36 areas throughout the area of the proposed pipeline where deer have been hunted. Other areas used for deer hunting include the North Salem area, Stewiacke and East Stewiacke areas, Brookfield, Pleasant Valley, and Birch Hill.

Small game is also harvested throughout the study area, with harvests ranging from Brookfield, at the northern part of the study area, to Indian Brook, located in the southern part of the study area. Harvested species include hares, ruffed grouse, porcupine, pheasant, fox, beaver, and geese. Of these, hares are the most frequently harvested resource, with over 200 harvested sites identified. For a map of areas where members of the Mi'kmaq community continue to hunt, refer to the MEKS in Appendix J.

Medicinal/Food/Spiritual Plants

Today, the Mi'kmaq continue to harvest plants for various uses, including food, art, and medicines. The MEKS discovered at least seven species of plants that Mi'kmaq continue to harvest for Mi'kmaq medicine, including flagroot and golden thread, both of which are primarily harvested in the Indian Brook, Brookfield and Stewiacke River areas. Also, these plants are harvested in the areas in and around the proposed pipeline. For a map of areas where members of the Mi'kmaq community continue to gather plants, refer to the MEKS in Appendix J.

6.7.4 Analysis, Mitigation and Residual Environmental Effects Prediction

While the majority of the significant species are widely available in other areas, the Mi'kmaq people continue to undertake traditional use activities within the study area, which includes a 10 km buffer zone beyond the Project area. Data analysis shows that the resource use from both the waters and lands is extremely significant and that the Shubenacadie and Stewiacke Rivers and their surrounding tributaries are key to harvesting these resources.

Based on the information gathered for the MEKS, it is likely that potential Project interactions with traditional land and resource use will be effectively managed through a variety of mitigative measures that are technically and economically feasible. These include mitigative measures described throughout this environmental assessment to protect other VECs that are of concern to traditional use (*e.g.*, vegetation, wildlife, fish and fish habitat) The MEKS recommends that the proponent and government meet with First Nation leadership to discuss any further issues of mutual concern including duty to consult with First Nations.

6.8 Archaeological and Heritage Resources

6.8.1 VSC Identification

For the purposes of this assessment, archaeological and heritage resources are defined as physical remains that inform us of the human use of and interaction with the physical environment. These

resources may be above and below the ground and cover the earliest prehistoric times to the relatively recent past. Archaeological and heritage resources are included as a VSC in this assessment in recognition of the interest of affected Aboriginal peoples, the general public as a whole, and provincial and federal regulatory agencies in ensuring the effective management of these resources. An archaeological resource is a work of past human activity, or zoological, botanical, geological, or other natural materials found in association with such activity, that:

- is primarily of value for its prehistoric, historic, cultural, or scientific significance; and
- lays on, or was buried or partially buried in land in the province, including land covered by water (Nova Scotia *Special Places Protection Act*).

Heritage resources are generally considered to include historic period sites such as cemeteries, heritage buildings and sites, monuments, and areas of significance to Aboriginal peoples and other groups. Prehistoric refers to the time before the arrival of non-Aboriginal peoples.

An MEKS was conducted for this Project and includes: a review of historic and current Mi'kmaq land and resource use in the vicinity of the proposed Project; a Mi'kmaw Species of Significance Survey; a discussion of potential impacts of the Project on Mi'kmaq land and resource use; and recommendations for further action or mitigation. Further details are included in Section 6.7.

6.8.2 Boundaries

Spatial boundaries for the assessment of archaeological and heritage resources include the proposed underground storage facility near Alton, Nova Scotia, and the proposed pipeline corridor along its entire length from the area overlaying the salt formations to the Shubenacadie River, with particular attention to the area immediately adjacent to the RoW.

Archaeological and paleontological resources in the province of Nova Scotia are protected under the Nova Scotia *Special Places Protection Act* administered by the Nova Scotia Museum of Natural History. Sites considered to be valued as archaeological or paleontological resources may not be disturbed except under strictly controlled conditions imposed by terms of a Heritage Research Permit. The Nova Scotia Museum is also responsible for approving or modifying recommended mitigation measures.

Information regarding archaeological and heritage resources within the Project area was gathered from a variety of sources including: through archival research, examination of archaeological resources files at the Nova Scotia Museum, air photo interpretation, and an archaeological site survey by a qualified archaeologist on July 10, 11, 13, 14, and 15, 2006.

6.8.3 Residual Environmental Effects Evaluation Criteria

A **significant residual adverse environmental effect** on archaeology and heritage resources is one where the disturbance to, or destruction of, an archaeological or heritage resource (including paleontological resources) that is considered by the provincial heritage and archaeological regulators to be of major importance due to factors such as rarity, undisturbed condition, spiritual importance, or research importance, and is an effect that cannot be mitigated.

A **positive** effect is one that results in enhanced understanding of local, regional, or cultural heritage through increased knowledge, or provides physical protection for a site that might otherwise have been destroyed through natural or non-Project anthropogenic events, in the absence of the Project.

6.8.4 Potential Interactions, Issues and Concerns

Certain activities associated with Project construction (*e.g.*, site preparation and pipeline installation) will cause surface or subsurface disturbances that could affect archaeological and heritage resources sites. These disturbances, if unmitigated, could result in the loss of the resource and the potential knowledge to be gained from its interpretation. The RoW intersects with high potential archaeological areas near Fort Ellis that may be adversely affected during construction of the proposed Project (see Section 5.11 and Figure 5.3).

Ground disturbance associated with construction will be short-term. However, any potential adverse effect on archaeological and heritage resources will be permanent, as no archaeological site can be returned to the ground in its original state. Longer-term increased erosion in or outside areas of direct physical disturbance could lead to adverse effects on the integrity of heritage resources in such areas.

6.8.5 Analysis, Mitigation and Residual Environmental Effects Prediction

The assessment of archeological and heritage resources focuses on the evaluation of potential interaction between the VSC and various Project activities as described in the previous section.

The development of the Project and related facilities will involve ground disturbance, which could affect any archaeological or heritage sites that may exist within the zone of surface or subsurface disturbance. The potential for disturbance to known sites or areas of high potential can be mitigated through further archeological testing and construction monitoring.

Given the potential to discover previously unknown archaeological resources, Alton will develop and implement an Archaeological Contingency Plan as part the Emergency Response and Contingency Plans. This Plan will include procedures for notification (*e.g.*, Curator of Archaeology at Nova Scotia Museum), requirements for work stoppage and conservation of resources. Worker awareness training will address archaeological resources and relevant procedures.

6.8.6 Follow-up and Monitoring

A Phase 1 archaeological impact assessment was conducted and identified two areas potentially housing significant archaeological resources: Village Hebere and Fort Ellis. The First Nations high potential determination is based on the presence of numerous First Nations sites along the Stewiacke River where location and topography is similar to that of Fort Ellis. The historic high potential determination is based on background research that showed the existence of Village Hebere, an early 18th Century Acadian village, and Fort Ellis, a minor, mid-18th Century British fort/blockhouse. The proposed pipeline will not affect the area where these identified resources are located, but there is concern that there may have been peripheral settlement associated with them, perhaps soldiers living with their families or even historic Mi'kmaq.

It is recommended that a program of shovel testing be employed to determine the presence of archaeological resources within the high potential areas. The shovel tests would begin at the centerline

of the pipe and move 10 m on either side; a total of five tests per line. It is also recommended that a professional archaeologist monitor any work that would impact the dykes in case any original dyke work is encountered. Archaeological fieldwork to mitigate potential adverse effects on heritage resources is more easily conducted between late spring and early autumn.

6.8.7 Summary of Residual Environmental Effects Assessment

The development of the Project and related facilities will involve ground disturbance, which could affect any archaeological or heritage sites that may exist within the zone of surface or subsurface disturbance. Assuming that recommended mitigative and monitoring measures are implemented, the overall residual environmental effect of the Project on archaeological and heritage sites is not likely to be significant for construction and operation.

With new information being gathered and made available to researchers, communities, regulators, and other stakeholders, the potential overall effect could be seen as positive.

7.0 MALFUNCTIONS AND ACCIDENTAL EVENTS

7.1 Introduction

The objective of the assessment of possible malfunctions and accidental events are to ensure that:

- abnormal events and/or operational upset conditions are considered;
- potential events are identified; and
- the significance of the residual effects (*i.e.*, after mitigation) of such events is determined.

The focus of the assessment is on those events considered credible in the context of the Project. It is not the intent of this report to address all conceivable abnormal occurrences, but rather, to address only those that have a reasonable probability of occurring or are perceived to have a reasonable probability of occurring (considering the specific aspects of site conditions and Project design) that may have an environmental effect or consequence.

The assessment also acknowledges malfunctions and accidental events that may be precipitated by external factors, either natural or anthropogenic. In the context of the assessment, external factors that lead to upset conditions are considered "initiating events." This assessment considers the likelihood of initiating events as well as the consequential effects of such events.

Malfunctions and accidental events that have been identified as requiring further assessment include:

- failure of the brine holding and mixing ponds leading to uncontrolled discharge of brine into adjacent fields and the Shubenacadie River;
- pipeline rupture leading to uncontrolled release of brine;
- failure of water storage/surge tank leading to uncontrolled release of brackish water;
- hazardous materials spill;
- fire (*i.e.,* electrical fire, forest fire);
- mechanical failure of wellheads, piping, or compressors leading to uncontrolled release of natural gas; and
- off-site or on-site traffic accident including collision with a wellhead on-site.

The brine holding pond and brine mixing pond adjacent to the Shubenacadie Estuary could undergo a breach or collapse of the containment dyke(s) or there could be an electrical failure of the intake and discharge gates. In such a case, the mixing pond would discharge a water and brine mixture which would be near Project discharge salinities. The worst case being that the brine holding pond would discharge brine at 260 ppt salinity. The discharge would flow onto the adjacent field which surrounds the two ponds and into the Shubenacadie Estuary via the field drainage ditches which are connected to the Estuary by a flap gate (aboiteau). The discharge would then disperse in the Estuary. The maximum volume of brine potentially discharged during a total collapse of a brine pond containment dyke is estimated at less than 5,000 m^3. Discharge from the mixing pond would drain to the field and the Estuary, resulting in flooding of the field with estuarine water which would drain back into the Estuary at low tide. Using best design and engineering practices, the ponds will be designed to prevent failure under a variety of environmental conditions, including high precipitation.

The water and brine pipelines which connect the intake and discharge facilities with the underground storage facility site will be buried to a depth of approximately 1.8 m. One or both pipelines could rupture because of a pipeline material failure or an unexpected surface excavation rupturing the pipeline. This would result in a flow of water and/or brine from the pipeline(s) into the nearby environment. A sudden pressure drop in the pipeline would result in an immediate shutdown of pumps. The amount of brine escaping into the environment would be limited to the volume in the pipe(s) which is higher in elevation than the breach. The total volume in each 12-km pipeline, with a diameter of 324 mm is 989 m^3. In the event of a malfunction or accident, a portion of this volume, composed of Estuary water and/or saturated brine, could be discharged into the nearby environment.

Water storage/surge tanks could rupture by material failure or due to input from a vehicle or heavy equipment and result in discharge into the nearby environment. The tank will be equipped with a secondary lined containment dyke to capture any leaked water. This dyke will also act as a barrier to physical damage by a vehicle. Regular inspection and maintenance of this system will ensure its integrity.

Hazardous material from equipment maintenance (*i.e.*, oil or fuel spill) could accidentally spill into the nearby environment. Spills would be limited to relatively small quantities, typically broken hydraulic systems or small amounts of spilled fuel. At most, up to 200 L of diesel fuel (one drum) could be expected to spill. A Spill Management Plan and Emergency Response and Contingency Plans will be in place to quickly address environmental risks associated with hazardous material spills, in the unlikely event one should occur. For example, these plans would address clean-up materials to be kept on site as well as clean-up procedures, notifications and worker training.

Once the salt caverns have been converted to natural gas storage caverns by displacing the brine with natural gas, compressors will facilitate pumping the gas into the caverns, or out of the caverns into the gas pipeline. Gas will free flow either way until the pressure reaches a level where the compressors are required. Given the depth of the caverns, the maximum operating pressure will be approximately 2000 psi (13,790 kPa). There is a possibility of mechanical failure of wellheads, piping, or compressors. This would result in high pressure gas escaping into the atmosphere. Since natural gas is lighter than air, the gas would rise upward and dissipate. Wind would affect the area of dissipation. The natural gas (methane) meets pipeline specifications, and therefore will not include hydrogen sulphide. If the escaping gas were to ignite, this could cause a localized explosion and fire which would be confined to the facility. The gas stored underground is not flammable as oxygen is unavailable for combustion. Automatic ESVs will be located at various points including at the wellheads and the facility will be in compliance with CSA Z341.

There is a possibility of a collision between a vehicle or heavy equipment and a wellhead. The wellheads are extremely strong and will be protected by a steel barrier. An uncontrolled escape of gas from a storage cavern would result in the loss of gas from that particular cavern only, as the caverns are isolated by a system of piping and valves. Any uncontrolled escape of gas would dissipate into the atmosphere and would not leave any surface residue. The storage facility is an industrial facility which will be secured by a fence and locked gate to prevent unauthorized access by the public.

7.2 Assessment of Malfunctions and Accidental Events

The objective of this assessment is to determine if any malfunction or accidental event could be expected to result in a residual environmental effect considering Project-specific features that would be available to prevent or control the occurrence itself, as well as to mitigate possible effects of the event. Proposed environmental and safety protection systems are described Section 2.5. These include measures to mitigate effects of regular construction and operation activities but also encompass management measures to address malfunctions and accidental events (*e.g.*, ESVs, Emergency Response and Contingency Plans).

All of the identified malfunction and accident scenarios are of a temporary nature and short duration. With the Project-inherent effect management measures (Section 2.5), malfunctions and accidental events are expected to be rare events and the consequences short-term and subject to immediate clean-up and corrective measures, if required.

Only those environmental components that are likely to be affected by accidents and malfunctions are discussed below. For example, Labour and Economy, Traditional Land and Resource Use, and Fisheries Resources are not considered to be sensitive to the identified scenarios. For the VSCs, the discussion of potential for adverse effects from malfunctions and accidental effects, therefore mainly focuses on Public Health and Safety. Table 7.1 provides an overview of potential interactions between Malfunctions and Accidental Events and Environmental Components.

TABLE 7.1 Potential Interactions Between Project Environmental Components and Malfunctions and Accidental Events

Malfunctions and Accidental Events	Environmental Components				
	Fish and Fish Habitat	Land and Resource Use	Terrestrial Environment	Archaeological and Heritage Resources	Public Health and Safety
Failure of the brine holding and mixing ponds leading to uncontrolled discharge of brine into adjacent fields and the Shubenacadie River	●	●	●		●
Pipeline rupture leading to uncontrolled release of brine	●	●	●	●	●
Failure of water storage/surge tank leading to uncontrolled release of brackish water		●	●		●
Hazardous materials spill	●	●	●	●	●
Fire (*i.e.,* electrical fire in the buildings, forest fire)			●		●
Mechanical failure of wellheads, piping, or compressors leading to uncontrolled release of natural gas, fire and explosion		●			●
On-site traffic including collision with a wellhead					●

7.2.1 Fish and Fish Habitat

Hazardous Materials Spill

A spill of potentially toxic materials associated with equipment involved in construction and maintenance of infrastructure could cause a variety of adverse effects on fish and fish habitat in the Estuary. Spill prevention is the most important step in preventing these potential effects. Prevention is based on effective and well-planned procedures and maintenance of equipment. These strategies will be outlined in a Project-specific Environmental Protection Plan, which will be developed prior to the onset of construction activities. Spills that could reasonably be expected to occur would be limited to relatively small quantities.

In the case of a minor spill, cleanup efforts would begin immediately in accordance with the Spill Management Plan and the Emergency Response and Contingency Plans. Based on the nature of materials used during construction and small quantities, mitigation and contingency planning, the majority of adverse environmental effects due to accidental spills are considered not significant. However, because of the possibility, albeit very low, of a substantial spill of a toxic substance directly into the Estuary or a fish-bearing stream (*i.e.,* concentrated brine), the environmental effects of an accidental hazardous spill on fish and fish habitat are considered significant, but not likely.

Uncontrolled Brine Discharge

An accidental discharge of concentrated brine could have acute toxic effects on fish and other aquatic organisms. The volume of uncontrolled brine discharge could be on the order of 5,000 m^3 at the holding pond and less than 989 m^3 from the pipeline. The proponent has committed to incorporating safety features into the design to reduce the risk of an accidental release of concentrated brine. For instance, the brine pipeline will be designed with automatic shutdowns, thus reducing the risk of concentrated brine being released to the Estuary in case of equipment failure. The water and brine pipelines will include measurement and control systems to monitor the volume entering each pipeline and compare it with the volume exiting. Should there be a small total change in flow volume on the intake line from the river to the underground storage facility, an alarm will be raised. A slightly larger change will initiate an automatic system shutdown. Should there be a 1% change in flow volume on the discharge line from the underground storage facility to the brine holding and mixing ponds, an alarm will be raised. A small change will initiate an automatic system shutdown. However, because of the possibility, albeit very low, of a release of concentrated brine to the Estuary, the environmental effects of an accidental hazardous spill on fish and fish habitat are considered significant, but not likely. Consequently, effects on migratory shorebirds which depend on components of fish and fish habitat (*i.e., C. volutator* as prey) are considered unlikely.

7.2.2 Land and Resource Use

Uncontrolled release of brine or hazardous materials spill has the potential to interact with soils and migrate beyond the pipeline RoW into groundwater. In addition to potentially contaminating soils, these accidental spills could cause loss of crops, timber and property damage. In terms of affecting groundwater, if brine is released in sufficient quantities, groundwater could be impacted.

Spills would be limited to relatively small quantities. The amount of material spilled during an accident would be on the order of 10 to 15 m^3 and/or 200 L of diesel fuel. It is expected that the volume of spilled

chemicals or a hazardous material will be less than about 200 L (*i.e.,* one drum). As explained above, the volume of uncontrolled brine discharge could be on the order of 5,000 m^3 at the holding pond and less than 989 m^3 from the pipeline. Should there be a small total change in flow volume on the intake line from the river to the underground storage facility, an alarm will be raised. A slightly larger change will initiate an automatic system shutdown. Should there be a 1% change in flow volume on the discharge line from the underground storage facility to the brine holding and mixing ponds, an alarm will be raised. A small change will initiate an automatic system shutdown. Cleanup efforts would begin immediately in accordance with the Spill Management Plan and Emergency Response and Contingency Plans and contaminated soil and/or water would be remediated to the appropriate standards. Communications with potentially affected landowners is also an important part of addressing the situation. Landowners would be compensated for any long term effects including loss of water supply and agricultural capacity.

Interaction between groundwater wells and gas leaking due to failure of a cavern is unlikely because the proposed caverns are much deeper than the maximum depth of potable ground water, and the intervening strata contain 380 m of additional impermeable salt, the physical properties of these salt formations make it unlikely to fracture, and safety systems and standards will minimize potential risks to groundwater users. A failure of a cavern well is also unlikely because these wells will have surface casing cemented to a depth of 100 m, which is below the depth of potable groundwater. The production casing will be cemented inside the surface casing. Both casings will be subjected to a cement bond log, and the production casing will be subjected to an inspection log and a mechanical integrity test prior to operation, after five years of operation and every ten years thereafter. Cathodic protection will be provided for the wells, and corrosion rates will be continuously monitored.Finally, flow rates into and out of each cavern will be monitored and compared with calculated volumes based on pressures to provide a continuous inventory balance. Any discrepancy will cause an automatic shutdown until an investigation and remedial action is taken.

7.2.3 Terrestrial Environment

On-site and off-site spills, including uncontrolled discharge of brine along the pipeline route and near the holding ponds, may be deposited in terrestrial habitats within the Project area. Spills of hazardous material (not including brine) would be limited to relatively small quantities. The volume of uncontrolled brine discharge could be on the order of 5,000 m^3 at the holding pond and less than 989 m^3 from the pipeline. Should there be a small total change in flow volume on the intake line from the river to the underground storage facility, an alarm will be raised. A slightly larger change will initiate an automatic system shutdown. Should there be a 1% change in flow volume on the discharge line from the underground storage facility to the brine holding and mixing ponds, an alarm will be raised. A small change will initiate an automatic system shutdown. Cleanup efforts would begin immediately in accordance with the Spill Management Plan and Emergency Response and Contingency Plans and contaminated soil and/or water would be remediated to the appropriate standards.

Rare Plants

During the construction phase of the Project, uncommon or rare plant species, particularly those growing in wetlands or aquatic habitats could be adversely affected by accidental discharges of fuel or other hazardous materials. Spills associated with construction activity are typically small; however,

since the distribution of rare plant populations is generally highly localized, there is a remote possibility that a spill could have an adverse effect on a local population. In the event of a spill, cleanup efforts would being immediately.

Forest fires resulting from careless brush burning or disposal of smoking materials could also adversely affect rare plant populations along the route. Retrorse sedge is the only one of the nine uncommon or rare plants encountered along the pipeline route that would be particularly vulnerable to fire since it was found in close proximity to forest habitat. The rest of the species were found in non-forested habitat. A fire could have a significant adverse effect on a rare plant population if it affected a significant proportion of the regional population. This would require a very large fire or a species that is concentrated in only a few locations. The probability that a fire would significantly affect a rare plant population is very low. Nevertheless, all reasonable efforts should be made to reduce the probability of a forest fire and the magnitude of any fire that does occur. Mitigative measures to accomplish this goal will be included in the Emergency Response and Contingency Plans.

During the operational phase of the Project, pipeline rupture could occur which could adversely affect rare plant species in areas where groundwater comes to the surface. Rare plants found on seepage tracks, wetlands, along riparian zones and in aquatic environments would be most susceptible. Most of the uncommon and rare plants recorded along the proposed pipeline route were not situated in habitats where brine contaminated groundwater is likely to come to the surface. The retrorse sedge population at the eastern end of the route is found in a seepy area near the base of a slope and could potentially be affected. Several of the alderleaf buckthorns found near Highway102 are situated in poorly drained areas downslope of the proposed pipeline route and could potentially be exposed to brine contaminated groundwater. Brine contaminated groundwater could potentially travel some distance before emerging possibly affecting rare plant populations outside of the Project footprint. The pipeline is equipped with leak detection sensors and an automatic shutdown system which would minimize the amount of brine lost in the event of a pipeline rupture.

There is potential for significant residual adverse environmental effects on vegetation as a result of Project-related accidental events (*i.e.*, large fire). However, provided mitigative measures are in place, such events are unlikely to occur.

Wildlife and Wildlife Habitat

A spill of potentially toxic materials associated with equipment involved in construction and maintenance of the pipeline and RoW could cause a variety of adverse effects on wildlife and wildlife habitat. In the event of a spill, cleanup efforts would begin immediately in accordance with the Spill Management Plan and Emergency Response and Contingency Plans and contaminated soil and/or water would be remediated to the appropriate standards. Further information on spill prevention and response is found in Section 2.5. Based on the nature of materials used during construction and small quantities, mitigation and contingency planning, the majority of adverse environmental effects due to accidental spills are considered not significant.

Pipeline ruptures could result in the release of brine into the soil which could enter surface water bodies used by wildlife. Changes in osmotic potential could kill amphibians and their eggs and larvae. No direct toxicity related mortality would be expected for other terrestrial invertebrates although some indirect effects could occur. Birds and mammals could also be adversely affected through ingestion of

brine. Other indirect adverse effects would include mortality of fish, amphibians and invertebrates that provide food sources for birds and mammals. The pipeline will be equipped with leak detection equipment and an automatic shutdown system that will reduce the amount of brine lost in the event of a pipeline rupture.

As with all accidental events, the most important step in preventing effects of forest fire is to prevent fires from occurring. Prevention of forest fires during construction, operation and maintenance is based on proper planning, care, procedures and maintenance of heavy equipment; these strategies, as well as response procedures, are outlined in Section 2.5 and will be further detailed in the EMP.

Because of the possibility, albeit very low, of a large forest fire, the environmental effects of an accidental forest fire on wildlife and wildlife habitat could be significant. However, in consideration of mitigation and contingency plans, significant adverse effects are not likely. Recoveries of habitat would begin after one generation and continue through a series of successional phases; nevertheless, the return of the terrestrial community to the pre-fire state could take multiple generations.

7.2.4 Archaeological and Heritage Resources

The effect of malfunctions and accidental events could be significant if archaeological or heritage resources are affected by unplanned removal of soil as a result of an accident or malfunction during the construction or operation phases of the Project. In particular, unplanned removal of soils near the area of high archaeological potential (Figure 5.4) have the potential of adversely affecting archaeological and heritage resources. All cleanup activities will require a licensed, professional archaeologist in attendance and a contingency plan in place as identified in Section 6.8. The result of any given spill has the potential for a significant adverse effect. The residual effect of malfunctions and accidental events may be significant. However, the probability of such accidents occurring is low given the design and safety features incorporated in the Project and the Emergency Response and Contingency Plans that will be in place.

7.2.5 Public Health and Safety

Public health and safety is identified as a public concern and there is potential for the Project to result in adverse effects to the health and safety of the general public.

Due to stringent regulatory requirements associated with the Project design and the comprehensive health and safety policy and procedures adopted for the Alton Storage Project, public health and safety interactions are not expected to be a result of normal construction and operation and maintenance activities. The only substantive Project interactions with public health and safety would likely be as a result of malfunctions or accidental events.

One of the most significant factors contributing to the safety of cavern storage in Canada is the mandatory requirement by all Canadian jurisdictions that the design and operation of cavern storage facilities be conducted in accordance with the requirements of CSA Standard Z341, *Storage of Hydrocarbons in Underground Formations*. The Technical Committee responsible for this standard investigates every pertinent incident worldwide and reviews the latest relevant technology, to ensure that the standard covers all potentially hazardous situations. Nonetheless, some potential interactions, issues, and concerns do exist.

Mechanical Failure

The greatest single cause of accidental releases and other incidents in storage operations, including cavern development, is probably from corrosion in the piping and/or equipment. In this case, the stored product, natural gas, is not corrosive, and will not in itself cause many issues. However, during cavern creation, the leach water at its source will contain salt and oxygen, resulting in a potentially corrosive mix. To alleviate this concern, the water will be de-aerated by mechanical means to lower its oxygen content below corrosive levels. Additionally, extensive corrosion monitoring will be performed in accordance with the requirements of the applicable codes and standards.

Potential environmental effects to public health and safety from an accidental release of natural gas will be mitigated by meeting CSA Standard Z341 and by implementing Emergency Response and Contingency Plans. Key elements of these Programs have been highlighted in Section 2.5 (Environmental and Safety Protection Systems).

Potential environmental effects to public well-being would likely be limited to persons in the vicinity of the Project area (*i.e.*, potentially affected landowners). Open communication with the public, continued public education on the Project and public participation in the consultation process are means to address public concern regarding safety. A dialogue with potentially affected landowners has already been initiated through promoting the open house on the Project, and follow-up by land agents (as described in Section 4.0). Although the probability of a natural gas leak is low, implementing the measures described above will further reduce the probability of such an accident occurring.

Hazard scenarios and risk associated with underground storage activities will be addressed in a Hazardous Operations (Hazops) study and risk assessment that will be based on the final design of the facility and the instrumentation and controls installed in compliance with the requirements of CSA Standard Z341. Typically, past incidents have involved corrosion, so monitoring and control of corrosion, and mitigation of the possible effects of corrosion, will be a significant component of the design and operation procedures. However, there are many other potential areas of concern that will be addressed in the design and procedures and reviewed in the Hazops study; all of these are included in the requirements of CSA Standard Z341.

Fire

Fires during the Project construction and operations and maintenance phases could have potential environmental effects to public health and safety. Potential environmental effects during the construction phase would result from the fires caused by the equipment and/or materials in construction, and/or forest fires caused by construction activities throughout the Project area. Potential environmental effects during the operations and maintenance phase would result from the unplanned ignition of the natural gas released to the environment in an uncontrolled fashion from an on-site rupture or leak.

Alton will have fire prevention and response procedures in place as described in Section 2.5. Because of the potential risk of an on-site leak or rupture and associated fire/explosion to staff that could be present in the immediate vicinity of the event, the potential adverse effects for public health and safety are considered significant. Such a significant effect; however, is considered highly unlikely as demonstrated by the extremely low historical probability.

Uncontrolled Brine Discharge

Spills, leaks, or accidental releases of brine during the brining process could adversely affect water quality including groundwater. A Spill Management Plan and Emergency Response and Contingency Plans will be developed and implemented to minimize the chances of any spill reaching any waterbody including groundwater, and also include mitigation measures to minimize impact if a spill does occur and reach a waterbody. In this situation, communications with potentially affected landowners will also be an important part of addressing the situation. Given prevention and response measures, the potential effects of uncontrolled brine discharge on public health and safety is not expected to be significant.

Determination of Significance

The potential for significant environmental effects on health and safety due to accidents, malfunctions or unplanned events would require a large release of natural gas resulting in a fire. A major accident, such as a release of gas and fire due to a mechanical failure, is highly unlikely, given:

- the exemplary safety record of CSA Z341 regulated underground hydrocarbon storage caverns;
- the commitment to implement a risk assessment to underpin the Project design; and
- the Environmental and Safety Protection System and associated Emergency Response and Contingency Plans.

The potential for malfunctions and accidental events are minimized and effective and timely emergency response will be provided if a malfunction or an accidental event occurs. Given these provisions, it is highly improbable that a fire or explosion of substantial size will occur. Therefore, residual adverse environmental effects of malfunctions or accidental events on Health and Safety could be significant, but are very unlikely.

The probability of an incident occurring at the Alton storage site is very low, but there have not been enough incidents in Canada to generate appropriate statistics to evaluate the probability. Jurisdictions outside Canada do not require compliance with CSA Standard Z341, but many have recently incorporated clauses from the standard in their regulations. Once the Project design is finalized, a Hazops study as outlined in CSA Standard Z341 Annex D will be performed on this Project (Section 2.5.3).

7.3 Follow-Up and Monitoring Measures

Follow up activities will be defined for each Project phase to ensure that planned mitigation is effective, to provide assurance that Alton Environment, Health and Safety policy objectives are being achieved, as the Project proceeds. These activities are defined Section 2.12 describing the gas storage operation and in Section 2.5 describing Environmental and Safety Protection Systems. Once the Project design is finalized, the Hazops study will proceed. Should any malfunction or accidental event occur, post-accidental monitoring will occur to ensure cleanup and necessary remediation have been effective.

8.0 SUMMARY AND CONCLUSIONS

This report describes and evaluates the potential environmental and socio-economic effects of the Project during all Project phases. The evaluation has included proposed mitigative measures, where required, to reduce or eliminate potential significant impacts arising from Project-related activities. The report is based on information collected during field surveys, modeling, consultation with government and non-government agencies and individuals, background research and professional judgment of the Study Team.

A scoping process was undertaken to identify the VEC/VSCs most appropriate for this assessment. This scoping included: regulator and stakeholder consultation; regulatory issues and guidelines; research; and professional judgment.

The following VECs and VSCs were selected for the assessment:

- Fish and Fish Habitat;
- Rare and Sensitive Flora;
- Wildlife and Wildlife Habitat;
- Land and Resource Use;
- Labour and Economy;
- Fisheries Resources;
- Traditional Land and Resource Use; and
- Archaeological and Heritage Resources.

Each of the VEC/VSCs selected for the assessment was evaluated for potential interactions between the VEC/VSC and Project activities during all Project phases (*i.e.*, construction, operation and maintenance). Malfunctions and accidental events that may occur were assessed separately. These interactions were evaluated for potential significance after application of technically and economically feasible mitigative measures, where appropriate, to reduce or eliminate potential adverse Project-related environmental effects. Environmental monitoring and follow-up measures will be undertaken, where necessary, to ensure compliance with applicable regulations, standards, and guidelines, as well as to verify impact predictions and refine mitigative measures, where required.

In conclusion, the Alton Natural Gas Storage Project is not likely to have significant adverse effects on the environment. Adverse environmental effects will be reduced to acceptable levels through the use of technically and economically feasible design and mitigative measures. Some positive effects from the Project are likely, particularly those related to increased economic activity.

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