Labrador-Island Transmission Link

Environmental Impact Statement

Volume 2A
Existing Biophysical Environment

nalcor energy
LOWER CHURCHILL PROJECT

This report has been printed on recycled Forest Stewardship Council-certified paper.

NALCOR ENERGY

LABRADOR-ISLAND TRANSMISSION LINK

ENVIRONMENTAL IMPACT STATEMENT

Chapter 10

Existing Biophysical Environment

April 2012

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

Acronym	**Definition**
‰	parts per thousand
%	percent
% sat	percent saturation
~	approximately
<	less than
>	greater than
°C	degrees Celsius
°N	degrees north
µg/L	micrograms per litre
$\mu g/m^3$	micrograms per cubic metre
µS/cm	micro Siemens per centimetre
ACCDC	Atlantic Canada Conservation Data Centre
AEK	Aboriginal Ecological Knowledge
AMEC	AMEC Earth and Environmental
AQHI	Air Quality Health Index
As	arsenic
BTEX	benzene, toluene, ethyl benzene, and xylenes
CAC	criteria air contaminants
$CaCO_3$	calcium carbonate
CCDA	Capital Coast Development Alliance
CCME	Canadian Council of Ministers of the Environment
CCRI	Community-based Coastal Resource Inventory
CDWQ	Canadian Drinking Water Quality
CHS	Canadian Hydrographic Service
cm	centimetre
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CTD	conductivity-temperature-depth
CWS	Canadian Wildlife Service
CWS and CWF	Canadian Wildlife Service and Canadian Wildlife Federation
dB	decibel
dBA	A-weighted
DFA	Department of Fisheries and Aquaculture
DFO	Fisheries and Oceans Canada
DND	Department of National Defence

Acronym	Definition
e.g.,	for example
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
EC	Environment Canada
ECSAS	Eastern Canadian Seabirds at Sea
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
ERCB	Energy Resources Conservation Board
FMD	Forest Management District
G	Global
GHG	greenhouse gas
GIS	geographic information system
GMV	gross merchantable volume
GNL	Government of Newfoundland and Labrador
GRH	George River Herd
Gt	gigatonnes
ha	hectare
HADD	Harmful Alteration, Disruption or Destruction
H_{sig} in metres	units of significant wave height
Hz	Hertz
i.e.,	that is
IBA	Important Bird Area
IEMR	Institute for Environmental Monitoring and Research
IUCN	International Union for Conservation of Nature
km	kilometres
km^2	square kilometres
km/hr	kilometres per hour
Kt	kilotonnes
LEK	Local Ecological Knowledge
LGL	LGL Limited
LSDA	Labrador Straits Development Association
LSF	Low Subarctic Forest
m	metres
m/s	metres per second
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mm	millimetre
mm eq.	millimetres equivalent
MMA	Moose Management Areas

Acronym	**Definition**
MMH	Mealy Mountains Herd
Mt	megatonnes
mV	milivolts
n.d.	no date
NAAQO	National Ambient Air Quality Objectives
ND	Not Detected
NEDC	Nordic Economic Development Corporation
NL	Newfoundland and Labrador
NLDEC	Newfoundland and Labrador Department of Environment and Conservation
NLDNR	Newfoundland and Labrador Department of Natural Resources
NLDWST	Newfoundland and Labrador Department of Works, Service and Transportation
NLESA	Newfoundland and Labrador *Endangered Species Act*
NLRWG	Newfoundland and Labrador Riparian Zone Working Group
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NPRI	National Pollutant Release Inventory
NRCan	Natural Resources Canada
NTU	Nephelometric Turbidity Units
O_3	ozone
OLABS	Offshore Labrador Biological Studies
ORP	Oxygen Reduction Potential
PAHs	polycyclic aromatic hydrocarbons
PAL	Protection of Aquatic Life
pers. comm.	personal communication
PM	particulate matter
PM10	particulates with a nominal aerodynamic diameter of 10 microns and less
PM2.5	particulates with a nominal aerodynamic diameter of 2.5 microns and less
PPWSA	Protected Public Water Supply Area
Project	Labrador-Island Transmission Link
PSU	practical salinity units
RORB	Red Ochre Regional Board
RWMH	Red Wine Mountains Herd
S/cm	siemens per centimetre
SARA	*Species at Risk Act* (federal)
Sikumiut	Sikumiut Environmental Management Ltd.
SiO_2	Reactive Silica
SO_2	sulphur dioxide
SO_4	dissolved sulphate
spp.	species

Acronym	Definition
SSAC	Species Status Advisory Committee
SSCC	Species of Special Conservation Concern
TEK	Traditional Ecological Knowledge
TLH#	Trans-Labrador Highway; # indicates phase when applicable
TSP	total suspended particulate matter
TSS	Total Suspended Solids
VEC	Valued Environmental Component
VOCs	volatile organic compounds

10 EXISTING BIOPHYSICAL ENVIRONMENT

10.1 Introduction

This chapter describes the existing natural environment relevant to the Labrador-Island Transmission Link (Project), including its atmospheric, terrestrial, freshwater and marine components. In doing so, it establishes the current, baseline environmental conditions from which likely Project-related changes (effects) will be assessed and evaluated later in the Environmental Impact Statement (EIS).

The chapter focuses on describing the existing environment that overlaps, and may therefore interact with, the proposed Project, while also recognizing the larger spatial and temporal dimensions and distributions of these environmental components and systems, as well as ensuring appropriate regional context. The description of the environment also reflects available Aboriginal traditional and community knowledge, as well as social, cultural and economic activities and values related to the described components.

Given the characteristics and diversity of the environmental components described in the following sections, the various information sources used, and the nature and extent of the Project itself, study areas vary by component and are identified in each relevant subsection. For those aspects of the biophysical environment that are eventually identified as Valued Environmental Components (VEC), specific Environmental Assessment (EA) study areas are defined later to focus and frame the environmental effects assessment (Chapters 11 to 14).

10.2 Atmospheric Environment

The existing conditions for Atmospheric Environment are established by describing the climate (in terms of long-term weather trends and greenhouse gas (GHG) emissions), the ambient air quality (the quality of the air outdoors), and the ambient sound levels (outdoor noise levels) in Newfoundland and Labrador (NL).

Climate is characterized by the composite or generally prevailing meteorological conditions of a region, including temperature, air pressure, humidity, precipitation, sunshine, cloudiness and winds, throughout the seasons, averaged over a series of years. GHG emissions are considered to be an indicator of the potential for climate change. This information includes the consideration of recent climate change, as reflected in the climate normals discussed.

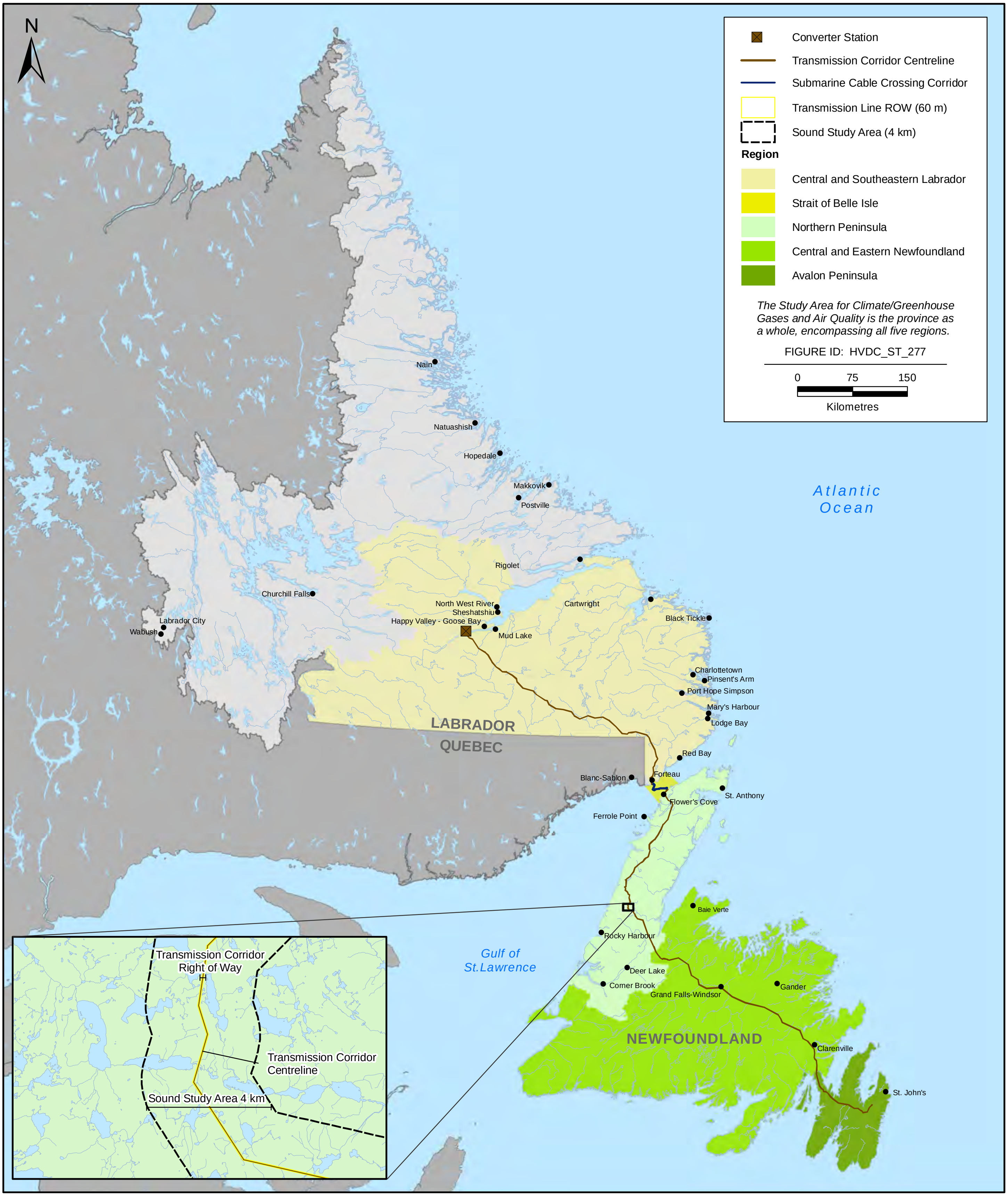
Ambient air quality is described by identifying the presence and concentrations of air contaminants in the atmosphere.

The existing ambient sound level is described by the presence, quality and pressure level of sound in a typical and representative rural environment which is considered appropriate for the transmission corridor.

10.2.1 Climate

10.2.1.1 Study Area

The Study Area for the existing climate is the province as a whole (Figure 10.2.1-1). The climate is described by the weather trends over a period of record that extends over 30 years. The GHG emissions from sources located within NL relate to climate in the province and the regions crossed by the Project; as a result, all sources within the five regions (i.e., Central and Southeastern Labrador, Strait of Belle Isle, Northern Peninsula, Central and Eastern Newfoundland and Avalon Peninsula) are included in this description of existing climate.



nalcor energy

Figure 10.2.1-1

Atmospheric Environment Study Area

10.2.1.2 Information Sources and Data Collection Methods

Available data and published literature have been used in preparing the description of the existing climate (described as climatology and GHG emissions), including sources of information from government agencies, academia, research organizations and technical sources of scientific data relating to GHG emissions and climate change. Also considered was the document *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (Canadian Environmental Assessment Agency (2003, internet site). The primary sources of information relating to climate used in this discussion include:

- National GHG emissions inventory, including the provincial and energy sector analyses from 1990 to 2005 (Environment Canada (EC) 2009, internet site);
- EC weather service sources, including the Canadian Climate Normals, 1971 to 2000 (EC 2010a, b, c, d, e, f, internet sites); and
- NL Climate and Weather (Virtual Museum of Labrador 2007, internet site; Bell 2002a, b, c, d, internet sites; NL Heritage Web Site Project 1999a, b, internet sites).

Information related to climate was obtained from existing sources. Given the large volume and available information, field work was not necessary to characterize existing climate conditions in the province.

Aboriginal Ecological Knowledge (AEK) has been collected from consultation initiatives with Aboriginal groups in the Study Area (a summary of all Aboriginal consultation initiatives conducted for the Project can be found in Chapter 7 of the EIS). Sources of AEK include, but are not limited to, land use surveys and interviews, reviews of existing published and unpublished literature and through the provision of information to Nalcor Energy (Nalcor) by an the Aboriginal group or organization.

10.2.1.3 Climatology

Labrador is bordered by the Province of Québec to the south, west and north-west, the Labrador Sea to the east, and the Strait of Belle Isle to the south-east. The western and central portions of Labrador are subject to long, cold winters and relatively stable weather patterns; however, the eastern coast of Labrador experiences much unsettled weather due to storms influenced by the Labrador Sea (NL Heritage Web Site Project 1999a, b, internet sites).

The Island of Newfoundland experiences variable day-to-day weather due to a stormy maritime climate, especially in the winter (EC 2006a, internet site). Summer in Newfoundland is short and cool. Temperatures inland average several degrees warmer than in coastal areas (EC 2006a, internet site). The Island of Newfoundland is situated between the cold water of the North Atlantic Ocean and the warmer water of the Gulf Stream, which influences climatic conditions, coming up from the Gulf of Mexico (NL Heritage Web Site Project 1999a, internet site).

The north-east coast of the Island has the lowest precipitation and experiences warm summers. The central portion of Newfoundland has stronger winds and heavy snowfall. The south coast and Avalon Peninsula experience mild winters, with heavy rainfall in autumn and early winter (NL Heritage Web Site Project 1999a, b, internet sites).

The climate zones for NL are described in Figure 10.2.1-2. Climate normals data for the five regions and corresponding climate zones are provided in the following sections.

Climate Zones of Newfoundland and Labrador.

Image modified by Duleepa Wijayawardhana with permission, 1998. Reproduced by permission of Gary E. McManus and Clifford H. Wood, *Atlas of Newfoundland and Labrador* (St. John's. Newfoundland: Breakwater. ©1991 MUNCL) Plate 6.1.

Northern Labrador Tundra climate - summers too short and cool to support full tree growth. Precipitation decreases toward north. Mountains and fjords create locally variable weather conditions, especially in summer.

Interior Labrador Most continental of the province's climate regimes. Lengthy, very cold winters with deep snow cover but relatively more settled weather patterns. Upper Lake Melville area has relatively shorter winters and warmer, sunnier summers.

Coastal Labrador Exposed to stormy or unsettled weather from Labrador Sea. Heaviest precipitation normally south of Groswater Bay. Occasional extremes of temperature during offshore wind directions in summer and winter.

West Coast Marine influence from Gulf of St. Lawrence normally reduces temperature extremes but causes increased precipitation, especially during fall and early winter, when snowfalls are most frequent. Locally severe wind speeds descend from Long Range Mountains during favorable winter weather patterns.

Western Mountains and Central Uplands Increasing elevation normally results in lower temperatures, greater cloudiness and precipitation and stronger winds. Heavy winter snow accumulations, especially toward west.

Northeast Coast and Central Lowlands Driest area on island. Occasional very low winter temperatures in valleys. Cool, late spring near the coast, where sea ice often persists into May. Generally warm and sunny summers.

South Coast and Avalon Relatively mild winters with considerable variation in snow cover. Heavy rainfalls from October through December. Summers cooled by low clouds and fogs near coasts, considerably brighter and warmer inland.

HVDC_ST_070

nalcor energy

Figure 10.2.1-2

Climate Zones of Newfoundland and Labrador

Central and Southeastern Labrador

The Central and Southeastern Labrador region is within the Coastal Labrador and Interior Labrador climate zones (Figure 10.2.1-2, NL Heritage Web Site Project 1999b, internet site). The climate of Labrador is subarctic and humid (EC 2006a, internet site). As this region is in the north-eastern corner of the North American continent and borders the North Atlantic Ocean, Labrador is susceptible to both maritime and continental air masses (Virtual Museum of Labrador 2007, internet site). Intense low-pressure weather systems characterize the fall, winter and spring seasons, with strong winds, heavy snowfall and rainfall common in the region. Winters are characteristically cold and summers are pleasant but short. Most areas in Labrador experience the first frost in early September. Temperatures usually begin to rise above 0 degrees Celsius (°C) in the southern and central areas in late-March. It takes approximately four weeks from these dates for the ground to become free of snow (Virtual Museum of Labrador 2007, internet site). The predominant annual average air flow in Labrador is west by north-westerly (Jacques Whitford 2000a, b).

There are few climate normals data available for Labrador; as such, climate normals for Central and Southeastern Labrador are best represented by data available for Happy Valley-Goose Bay, Labrador (Table 10.2.1-1) and Blanc-Sablon, Québec (Table 10.2.1-2). These stations are located approximately 75 kilometres (km) north-east and 25 km west of the transmission corridor, respectively.

Table 10.2.1-1 Canadian Climate Normals at Happy Valley-Goose Bay, Labrador, 1971 to 2000

	Minimum	Month	Maximum	Month	Annual[(a)]
Temperature					
Daily Average (°C)	-18.1	January	15.4	July	-0.5
Daily Max. (°C)	-12.9	January	20.9	July	4.5
Daily Min. (°C)	-23.3	January	9.7	July	-5.6
Record Max. (°C)	10.6	January	37.8	July	–[(b)]
Record Min. (°C)	-39.4	February	0.1	July	–
Precipitation					
Rainfall (millimetre (mm))	1.9	January	114	July	560
Snowfall (centimetre (cm))	0.0	July / August	80.2	January	459
Total (mm eq.)	55.1	February	114	July	949

Source: EC (2010a, internet site).
Note: Latitude: 53°19'N; Longitude: 60°25'W; Elevation: 48.80 metres (m).
mm eq. = millimetres equivalent (water content of all forms of precipitation).
(a) Annual average for temperature and annual total for precipitation.
(b) — = Not Applicable.

Table 10.2.1-2 Canadian Climate Normals at Blanc-Sablon, Québec, 1971 to 2000

	Minimum	Month	Maximum	Month	Annual[a]
Temperature					
Daily Average (°C)	-13.3	January	12.6	August	0.2
Daily Max. (°C)	-8.2	January	16.5	August	4.3
Daily Min. (°C)	-18.4	January	8.8	August	-3.8
Record Max. (°C)	7.8	December	26.5	August	–[b]
Record Min. (°C)	-34.1	February	1.8	August	–
Precipitation					
Rainfall (mm)	7.1	February	108	July	654
Snowfall (cm)	0	July / August / September	99.3	January	412
Total (mm eq.)	51.6	April	110	January	1,067

Source: EC (2010b, internet site).
Note: Latitude: 51°27'N; Longitude: 57°11'W; Elevation: 36.90 m.
mm eq. = millimetres equivalent (water content of all forms of precipitation).
[a] Annual average for temperature and annual total for precipitation.
[b] — = Not Applicable.

Prevailing winds at the Goose Bay Airport are west by south-westerly, along the axis of the Churchill River valley, resulting in a microclimate within the valley, particularly at lower elevations (EC 2010a, internet site). The valley exhibits a boreal eco-climatic regime. Calm days are infrequent, with a mean of only 22 days per year at the Goose Bay Airport (Jacques Whitford 2000a, b). Annual precipitation is 949 mm, 48 percent (%) of which is comprised of snow (EC 2010a, internet site).

Prevailing winds at the Blanc-Sablon station are from the south-west (EC 2010b, internet site). The average wind speed experienced at this station is 19.3 kilometres per hour (km/hr). Annual precipitation varies from 51.6 mm to more than 109.5 mm in January at the Blanc-Sablon station (EC 2010b, internet site). Snowfall comprises approximately 39% of precipitation in the area (EC 2010b, internet site).

Strait of Belle Isle

The Strait of Belle Isle borders the Coastal Labrador and West Coast climate zones (Figure 10.2.1-2). This region is characterized by cool summers and cold winters. Fog is common on the Strait of Belle Isle year-around (Bell 2002a, internet site). Greater precipitation and stronger winds occur in this region (NL Heritage Web Site Project 1999b, internet site).

Climate normals data for Flower's Cove (located on the shore of the Strait of Belle Isle) from EC (2010c, internet site) are provided in Table 10.2.1-3. This station is located within 10 km of the transmission corridor.

Table 10.2.1-3 Canadian Climate Normals at Flower's Cove, Newfoundland, 1971 to 2000

	Minimum	Month	Maximum	Month	Annual[a]
Temperature					
Daily Average (°C)	-11.4	February	13.1	August	1.2
Daily Max. (°C)	-7	February	17.1	August	5
Daily Min. (°C)	-15.8	February	9.1	August	-2.6
Record Max. (°C)	10	March	26	August	–[b]
Record Min. (°C)	-34	February	2	August	–
Precipitation					
Rainfall (mm)	12.4	January	113	July	785
Snowfall (cm)	0	July / August / September	75.1	January	277
Total (mm eq.)	56.4	April	112	June	1,063

Source: EC (2010c, internet site).
Note: Latitude: 51°20'N; Longitude: 56°41'W; Elevation: 9.00 m.
mm eq. = millimetres equivalent (water content of all forms of precipitation).
[a] Annual average for temperature and annual total for precipitation.
[b] — = Not Applicable.

Northern Peninsula

The Northern Peninsula is located within three climate zones (Figure 10.2.1-2): the West Coast; the Western Mountains and Central Uplands; and the Northeast Coast and Central Lowlands. The climate of the Northern Peninsula is maritime, with cool summers and mild winters (Bell 2002b, internet site). Locally severe winds in the winter can occur (NL Heritage Web Site Project 1999b, internet site). Climate normals data for Rocky Harbour (located on the Northern Peninsula) (EC 2010d, internet site) are provided in Table 10.2.1-4. This station is located approximately 50 km west of the transmission corridor.

Central and Eastern Newfoundland

Central and Eastern Newfoundland is located within three climate zones (Figure 10.2.1-2): Western Mountains and Central Uplands; Northeast Coast and Central Lowlands; and South Coast and Avalon. The central portion of Newfoundland is the warmest (Bell 2002c, internet site). The northern and southern coasts are cooler in the summer and warmer in the winter than the inland portions. Fog is a common occurrence (Bell 2002c, internet site). Heavy snow accumulation occurs in this region (NL Heritage Web Site Project 1999b, internet site). Climate normals data for Grand Falls (located in the central region of Newfoundland) (EC 2010e, internet site) are provided in Table 10.2.1-5. This station is located within 10 km of the transmission corridor.

Table 10.2.1-4 Canadian Climate Normals at Rocky Harbour, Newfoundland, 1971 to 2000

	Minimum	Month	Maximum	Month	Annual[a]
Temperature					
Daily Average (°C)	-8.9	February	15.4	July	3.6
Daily Max. (°C)	-4.4	February	19.6	July	7.5
Daily Min. (°C)	-13.3	February	11.2	July	-0.4
Record Max. (°C)	14	February	29.5	July	–[b]
Record Min. (°C)	-36	February	1.7	July	–
Precipitation					
Rainfall (mm)	20.9	February	131	October	898
Snowfall (cm)	0	June / July / August / September	115	January	418
Total (mm eq.)	66.4	April	146	January	1,317

Source: EC (2010d, internet site).

Note: Latitude: 49°34'N; Longitude: 57°53'W; Elevation: 67.70 m.

mm eq. = millimetres equivalent (water content of all forms of precipitation).

[a] Annual average for temperature and annual total for precipitation.

[b] – = Not Applicable.

Table 10.2.1-5 Canadian Climate Normals at Grand Falls, Newfoundland, 1971 to 2000

	Minimum	Month	Maximum	Month	Annual[a]
Temperature					
Daily Average (°C)	-8.2	February	17.3	July	4.4
Daily Max. (°C)	-2.9	February	23	July	9.3
Daily Min. (°C)	-13.5	February	11.6	July	-0.5
Record Max. (°C)	12.5	January	34.4	July	–[b]
Record Min. (°C)	-35.6	January	0.5	July	–
Precipitation					
Rainfall (mm)	25.7	February	103	August	786
Snowfall (cm)	0	July / August / September	60.8	January	281
Total (mm eq.)	76.2	May	103	August	1,079

Source: EC (2010e, internet site).

Note: Latitude: 48°56'N; Longitude: 55°40'W; Elevation: 60.0 m.

mm eq. = millimetres equivalent (water content of all forms of precipitation).

[a] Annual average for temperature and annual total for precipitation.

[b] — = Not Applicable.

Avalon Peninsula

The Avalon Peninsula is located in the South Coast and Avalon climate zone (Figure 10.2.1-2). The climate of the Avalon Peninsula is strongly influenced by the cold waters of the North Atlantic Ocean. Cool foggy summers and cold winters are typical of the region (Bell 2002d, internet site). Heavy rainfalls in the fall are common (NL Heritage Web Site Project 1999b, internet site). Climate normals data for St. John's (located on the Avalon Peninsula) (EC 2010f, internet site) are provided in Table 10.2.1-6. This station is located to the north-east of the transmission corridor.

Table 10.2.1-6 Canadian Climate Normals at St. John's, Newfoundland, 1971 to 2000

	Minimum	Month	Maximum	Month	Annual[a]
Temperature					
Daily Average (°C)	-5.4	February	15.5	August	4.7
Daily Max. (°C)	-1.5	February	20.3	July	8.7
Daily Min. (°C)	-9.3	February	11.1	August	0.6
Record Max. (°C)	15.2	January	31.5	July	–[b]
Record Min. (°C)	-23.8	March	0.5	August	–
Precipitation					
Rainfall (mm)	60.5	February	159	October	1,191
Snowfall (cm)	0	July / August / September	79.9	January	322
Total (mm eq.)	89.4	July	161.9	October	1,514

Source: EC (2010f, internet site).
Note: Latitude: 47°37'N; Longitude: 52°44'W; Elevation: 140.5 m.
mm eq. = millimetres equivalent (water content of all forms of precipitation).
[a] Annual average for temperature and annual total for precipitation.
[b] — = Not Applicable.

Aboriginal Ecological Knowledge

AEK regarding climate in parts of the Study Area was obtained through interviews completed with Labrador Innu. This information is included in the list below (Table 10.2.1-7) and includes information on climate change. The information provided is generally in keeping with the scientific data obtained through the field studies and literature review conducted for the EA (as reported in Section 10.2.1.2).

Table 10.2.1-7 Aboriginal Ecological Knowledge of Climate in the Study Area

Group	Source	Quote (Direct and / or Indirect)
Labrador Innu	Labrador Innu Traditional Knowledge Committee Member, February 26, 2007 (p. 76)[a]	*Direct* "The weather is changing, and because of this there are new animals coming here. When I was in the country, I hadn't felt the change yet. There used to be lots of cold weather in the past, but I haven't felt the cold weather for some time. In the past I used to get frost bite on my face when out hunting."

[a] Source: *Innu Environmental Knowledge of the Mishta-shipu (Churchill River) Area of Labrador in Relation to the Proposed Lower Churchill Project* (Armitage 2007). Refer to Appendix 10-1.

Summary

Overall, the climatology of NL is consistent across the province, with no substantive differences between the five regions.

Climate change is widely recognized as being linked to global warming which has been associated with the release of GHG to the atmosphere (Intergovernmental Panel on Climate Change 2007). Thus, GHG emissions are considered to be an indicator of the potential for climate change. Due to this link between climate change and GHG emissions, a brief description of the GHG emissions from the Province of NL is provided below.

10.2.1.4 Greenhouse Gas Emissions

In Canada, facilities that release in excess of 100 kilotonnes (Kt) carbon dioxide (CO_2) carbon dioxide equivalent (CO_2e) and meet other reporting requirements, must report GHG emissions to EC (EC 2009, internet site). The reporting threshold was decreased to 50 Kt CO_2e for the 2009 reporting year (EC 2010g, internet site).

In 2008, seven facilities in NL reported GHG emissions. The facilities and the 2008 reported emissions are presented in Table 10.2.1-8. Carbon dioxide equivalent was calculated by EC and assumes 100-year global warming potentials (EC 2008a, internet site).

Table 10.2.1-8 2008 Reported Greenhouse Gas Emissions from Facilities in Newfoundland and Labrador (tonnes per year)

NPRI ID	Facility Name	Location	CO_2	CH_4	N_2O	CO_2e
6096	Hibernia Management and Development - Hibernia Platform	Atlantic Ocean	556,231	1664.8	14.7	595,749
5013	Iron Ore Company of Canada - Carol Project	Western Labrador	1,238,196	24.9	15.7	1,243,582
4316	North Atlantic Refining LP - North Atlantic Refining	Avalon Peninsula	1,285,356	–	–	1,285,356
17631	Petro-Canada - Terra Nova	Atlantic Ocean	576,456	1,489	34.2	618,326
4882	Newfoundland and Labrador Hydro - Holyrood Thermal Generating Station	Avalon Peninsula	861,891	9.41	17.8	867,607
8060	Husky Energy - Searose FPSO	Atlantic Ocean	515,691	1,431	31.6	555,534
5460	Wabush Mines - Scully Mine	Western Labrador	106,602	1.73	2.01	107,262

Source: EC (2008a, internet site).
Note: NPRI = National Pollutant Release Inventory; CH_4 = methane; N_2O = nitrous oxide.

The total GHG emissions reported by facilities in NL in 2008 were 5.2 megatonnes (Mt) CO_2e (EC 2010h, internet site). The total GHG emissions reported in Canada in 2008 were 0.26 gigatonnes (Gt) CO_2e (EC 2010i, internet site). Emissions from NL represent approximately 2% of the nation’s total GHG emissions, demonstrating that the contribution by the province to global climate change is small.

10.2.2 Air Quality

In establishing the existing conditions for Air Quality, both emissions and ambient air quality are considered. The emissions from existing sources are estimated and compared to provincial totals to provide context. Ambient air quality is described in terms of the ambient concentrations of air contaminants, such as total suspended particulate matter (TSP) (including dust), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), volatile organic compounds (VOCS) and polycyclic aromatic hydrocarbons (PAHs), where these values are compared with the ambient regulatory standards.

10.2.2.1 Study Area

The Study Area for ambient area quality is the province as a whole, as shown in Figure 10.2.1-1. As ambient air quality may be adversely affected by the emissions of air contaminants to the atmosphere a description of these sources located within the province is included in the description of existing conditions.

10.2.2.2 Information Sources and Data Collection Methods

Both available data and published literature have been used in preparing the description of the existing Atmospheric Environment, including information from government agencies, academia, research organizations and technical sources of scientific data relating to air quality. The primary sources of information relating to air quality and air contaminants are:

- EC's National Pollutant Release Inventory (NPRI) (EC 2008a, internet site) for estimates of criteria air contaminant emissions in the regions. The NPRI is the system through which facilities report emissions of specific NPRI substances to EC.
- EC's National Air Pollution Surveillance Network (EC 2008b) for information on existing ambient concentrations of air contaminants. There were six National Air Pollution Surveillance stations in operation in 2006, the latest reporting year for ambient air concentration data (EC 2008b). Three of the stations (located at St. John's, Corner Brook, and Mount Pearl) monitor SO_2, nitrogen dioxide (NO_2), CO, $PM_{2.5}$ and ozone (O_3); the remaining three stations (located at Grand Falls-Windsor, Happy Valley-Goose Bay and Ferrole Point) monitor O_3. VOCs were not monitored in Newfoundland or Labrador in 2006.
- NPRI 2008 Facility Data Summary (EC 2010j, internet site).

These data are taken from ambient air quality monitoring stations located within NL. In the absence of available data in the transmission corridor, the data from the nearest ambient monitoring stations are used to establish existing conditions relative to the transmission corridor. These data are representative of existing conditions because air contaminants are transported via large air masses within larger weather systems as they move across the province and the five regions, and at background levels, these are not likely to change substantively.

Ambient air quality data were obtained from federal databases available on-line. Given the large volume of available information, No fieldwork or ambient air quality monitoring was not necessary.

Ambient air quality data were compared to ambient air quality criteria, which are routinely used as a basis of comparison for air quality assessments. The National Ambient Air Quality Objectives (NAAQO) (Health Canada 2006, internet site) and the NL Maximum Permissible Ground-level Concentrations (Government of Newfoundland and Labrador (GNL) 2004, internet site) for the selected air contaminants considered as part of this EIS are presented in Table 10.2.2-1 (where they exist) for reference and comparison with observed data. These are supplemented, where required or available, by other national initiatives such as the Canada-Wide Standards from the Canadian Council of Ministers of the Environment (CCME) (CCME 2000, internet site), as well as standards and objectives from other jurisdictions, to provide a quantitative basis for comparison with available ambient air quality data from federal monitoring stations, reported by the National Air Pollution Surveillance Network (EC 2008a, internet site), for the selected air contaminants.

Table 10.2.2-1 Ambient Air Quality Objectives, Guidelines or Standards for Newfoundland and Labrador and Canada

Air Contaminant	Averaging Period	Newfoundland and Labrador Maximum Permissible Ground-Level Concentrations[a] ($\mu g/m^3$)	National Ambient Air Quality Objective[b] ($\mu g/m^3$)			Other Ambient Air Quality Standards or Objectives ($\mu g/m^3$)
			Maximum Desirable	Maximum Acceptable	Maximum Tolerable	
Sulphur dioxide (SO_2)	1-hour	900	450	900	–[c]	–
	24-hour	300	150	300	800	–
	Annual	60	30	60	–	–
Nitrogen dioxide (NO_2)	1-hour	400	–	400	–	–
	24-hour	200	–	200	300	–
	Annual	100	60	100	1,000	–
Carbon monoxide (CO)	1-hour	35,000	15,000	35,000		–
	8-hour	15,000	6,000	15,000	19,500	–
Suspended particulate matter (TSP)	24-hour	120	–	120	400	–
	Annual	60	60	70	–	–
Particulate matter less than 10 microns (PM_{10})	24-hour	50	–	–	–	50[d]
Particulate matter less than 2.5 microns ($PM_{2.5}$)	24-hour	25	–	–	–	30[e]
Ozone (O_3)	1-hour	160	100	160	300	–
	8-hour	87	–	–	–	128[f]
	24-hour	–	30	50	–	–
	Annual	–	–	30	–	–

Note: — = No standard or objective available.
$\mu g/m^3$ = micrograms per cubic metre.
[a] GNL (2004, internet site), *Air Pollution Regulations*, Schedule A.
[b] Health Canada (2006, internet site), NAAQO.
[c] No data available.
[d] British Columbia Ministry of Environment (BCMOE 2009, internet site), Air Quality Objectives and Standards for British Columbia and Canada.
[e] CCME (2000, internet site), Canada-Wide Standards for PM and O_3. Achievement based on the 98th percentile measurement annually, average over three consecutive years.
[f] CCME (2000, internet site), Canada-Wide Standards for PM and O_3. Achievement based on the 4th highest measurement annually, average over three consecutive years (65 parts per billion (ppb)).

For most air contaminants, the NAAQO have three levels: (i) the maximum desirable ambient air concentration; (ii) the maximum acceptable ambient air concentration; and (iii) the maximum tolerable ambient air concentration (Table 10-2.2-1). The maximum desirable and maximum acceptable ambient air concentrations are the most protective of the environment. For this description of air quality, the maximum acceptable NAAQO are used for comparison with available ambient air quality data.

Nationally, there exists Canada-Wide Standards designed to address the long-term ambient air concentrations of $PM_{2.5}$ and O_3. The Canada-Wide Standards for O_3 are defined as the fourth highest 8-hour average concentration measurement annually, averaged over three years. The Canada-Wide Standard for $PM_{2.5}$ is defined as the 98th percentile of the 24-hour average concentrations annually, averaged over three years. For this description of air quality, the most recent years of available data (2004 to 2006) were selected for comparison to the Canada-Wide Standard (EC 2008a, internet site).

Air quality indicators such as the air quality index (AQI) have been used for many years by EC, and a similar index has been used in New Brunswick to categorize existing air quality based on monitoring data in the past. EC's AQI has now been replaced by the Air Quality Health Index (EC 2008c, internet site), which is mainly concerned with human health. Under this system, and based on knowledge of the ambient concentrations, a ranking on the Air Quality Health Index has been developed from 1 to 10, where 1 = low air quality health risk and 10 = high air quality health risk. Therefore, the Air Quality Health Index can be used to assess risk to human health, but is not used to categorize existing air quality specifically.

In the establishment of ambient air quality, each air contaminant has been given an index level by one provincial jurisdiction, the New Brunswick Department of Environment, based on measured concentration and environmental and health effects. The highest index level determined the overall AQI for the region. The levels were defined as good, fair, poor and very poor. In this system, "good" is defined as concentrations that are below the maximum desirable NAAQO and "fair" is defined as concentrations that are above the maximum desirable NAAQO but are below the maximum acceptable NAAQO (Government of New Brunswick 2009). These terms are used herein to describe the air quality in NL.

10.2.2.3 Sources of Air Contaminants

Air quality in NL is characterized by ambient concentrations of air contaminants that have been emitted by sources both within the province and from outside (i.e., long-range transport). As such, the emissions of air contaminants along with ambient air monitoring data establish the existing air quality and are presented in the following sections.

The substantive sources of emissions in NL are reported to the NPRI. Examples of NPRI reportable substances include, but are not limited to:

- criteria air contaminants (CAC) (e.g., SO_2, NO_2, CO);
- VOCs (e.g., benzene, toluene, ethyl alcohol); and
- PAHs.

Since ambient concentrations of CAC are regulated both provincially and federally, this discussion focuses on these substances. In 2008, 99 facilities in NL reported emissions to the NPRI. Of these facilities, 59 reported CAC emissions information for facilities located in the five regions considered for this Project is provided in the following sections (Figure 10.2.2-1).

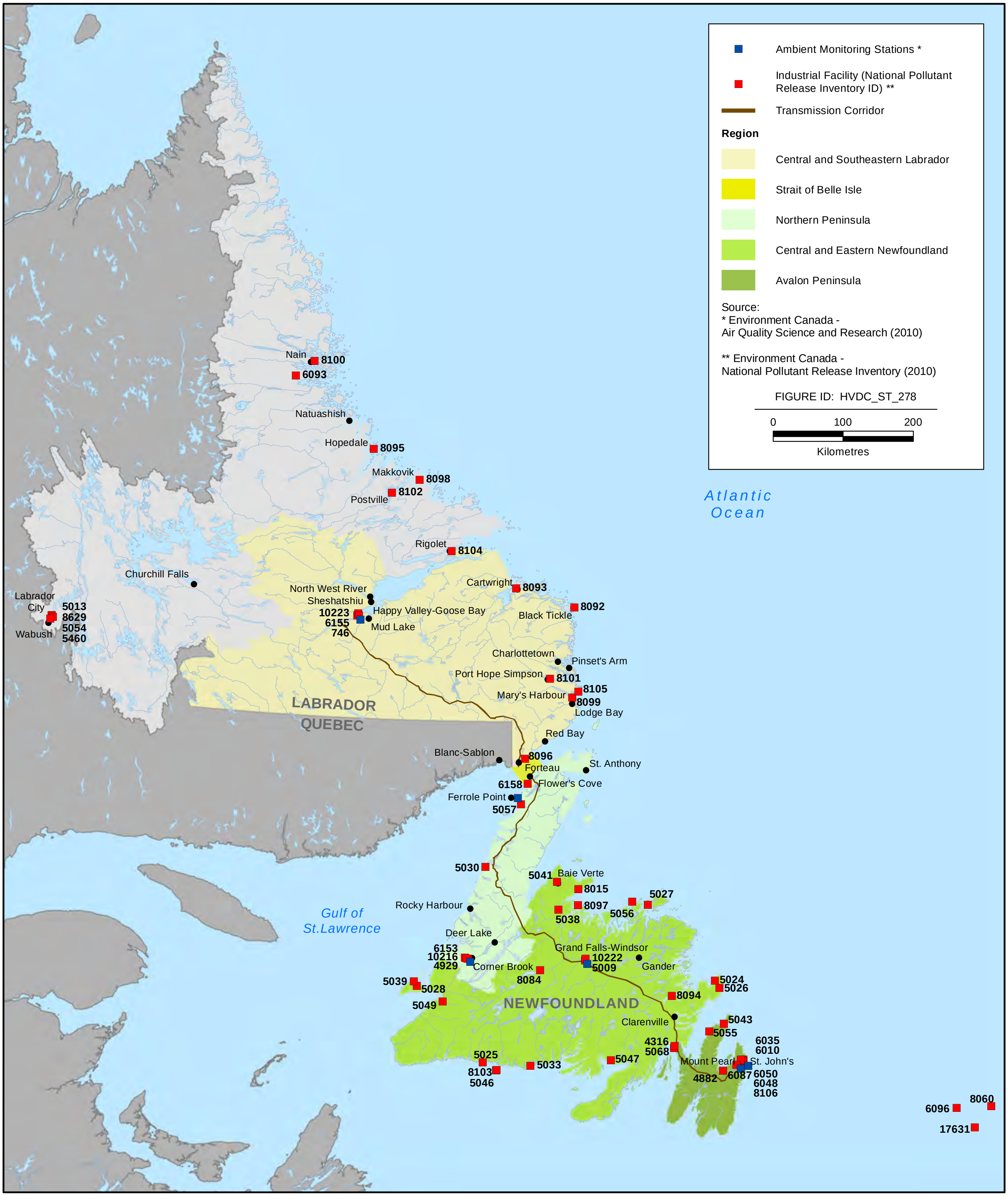


Figure 10.2.2-1

Ambient Monitoring Stations and Industrial Facilities in Newfoundland and Labrador Reported to the National Pollutant Release Inventory (2008)

Central and Southeastern Labrador

Nine facilities in Central and Southeastern Labrador reported CAC emissions. These facilities include power plants, and petroleum terminals. CAC Emissions from the reported facilities in Central and Southeastern Labrador are presented in Table 10.2.2-2 (EC 2008b).

Table 10.2.2-2 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Central and Southeastern Labrador

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X[a]	VOCs	Total PM	PM_{10}	$PM_{2.5}$[b]
746	Department of National Defence (DND) - 5 Wing Goose Bay	Happy Valley-Goose Bay	–[c]	–	–	–	–	0.53	–
8092	Newfoundland and Labrador Hydro - Black Tickle Diesel Generating Station	Black Tickle	–	–	31	–	–	–	–
8093	Newfoundland and Labrador Hydro - Cartwright Diesel Generating Station	Cartwright	–	–	159	–	–	–	–
8099	Newfoundland and Labrador Hydro - Mary's Harbour Diesel Generating Station	Mary's Harbour	–	–	95	–	–	–	–
8101	Newfoundland and Labrador Hydro - Port Hope Simpson Diesel Generating Station	Port Hope Simpson	–	–	77	–	–	–	–
8104	Newfoundland and Labrador Hydro - Rigolet Diesel Generating Station	Rigolet	–	–	56	–	–	–	–
8105	Newfoundland and Labrador Hydro - St. Lewis Diesel Generating Station	St. Lewis	–	–	46	–	–	–	–
6155	Ultramar - Goose Bay Terminal	Goose Bay	–	–	–	43	–	–	–
10223	Woodward's Oil Limited - Goose Bay Terminal	Goose Bay	–	–	–	19	–	–	–
Total			**–**	**–**	**464**	**62**	**–**	**0.53**	**–**

Source: EC (2008b).
[a] NO_X as NO_2.
[b] Source: EC (2008d, internet site).
[c] No data available.

Strait of Belle Isle

As the Strait of Belle Isle refers to the water between Labrador and Newfoundland, there are no facilities in this area that reported to NPRI. However, the two facilities that reported to NPRI on either side of the Strait of Belle Isle, at L'Anse au Loup (14 km north-east of Forteau) and St. Barbe (12 km south of Flower's Cove), have been chosen to represent the ambient air quality for the Strait of Belle Isle region (Figure 10.2.2-1). Furthermore, air contaminant emissions from ship traffic are not reported to NPRI. As a result, air emissions from ships travelling through the Strait of Belle Isle are not included in this discussion, but likely are not a meaningful contributor.

CAC Emissions from the facilities (i.e., marine terminal and generating station) chosen to represent the Strait of Belle Isle region are presented in Table 10.2.2-3 (EC 2008b).

Table 10.2.2-3 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Strait of Belle Isle

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X[a]	VOCs	Total PM	PM_{10}	$PM_{2.5}$[b]
6158	Ultramar - St. Barbe Marine Terminal	St. Barbe	–[c]	–	–	19	–	–	–
8096	Newfoundland and Labrador Hydro - L'Anse au Loup Diesel Generating Station	L'Anse au Loup	–	–	60	–	–	–	–
Total			**–**	**–**	**60**	**19**	**–**	**–**	**–**

Source: EC (2008b).
[a] NO_X as NO_2.
[b] Source: EC (2008d, internet site).
[c] No data available.

Northern Peninsula

Five facilities on the Northern Peninsula (Figure 10.2.2-1) reported CAC emissions. These facilities include petroleum terminals, a pulp and paper mill, and two waste incinerators (Table 10.2.2-4) (EC 2008b).

Central and Eastern Newfoundland

Twenty-one facilities in Central and Eastern Newfoundland (Figure 10.2.2-1) reported emissions of CAC. These facilities include waste incinerators, a pulp and paper mill, petroleum terminals, power plants, a petroleum refinery, and mining operations (Table 10.2.2-5) (EC 2008b).

Table 10.2.2-4 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Northern Peninsula

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X	VOCs	Total PM	PM_{10}	$PM_{2.5}$[(b)]
4929	Corner Brook Pulp and Paper – Corner Brook	Corner Brook	280	140	206	145	40	39	35
10216	Imperial Oil – Corner Brook Terminal	Corner Brook	–[(a)]	–	–	147	–	–	–
5030	Town of Daniel's Harbour – Regional Incinerator	Daniel's Harbour	–	37	–	12	22	15	14
5057	Town of Shoal Cove West – Waste Treatment Operation	Shoal Cove West	–	–	–	–	–	1.7	1.5
6153	Ultramar – Corner Brook Marine Terminal	Corner Brook	–	–	–	49	–	–	–
Total			**280**	**177**	**206**	**353**	**62**	**55.7**	**50.5**

Source: EC (2008b).
(a) No data available.
(b) Source: EC (2008d, internet site).

Table 10.2.2-5 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Central and Eastern Newfoundland

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X[(a)]	VOCs	Total PM	PM_{10}	$PM_{2.5}$[(b)]
5009	Abitibi Consolidated of Canada - Grand Falls Division	Grand Falls-Windsor	584	948	238	253	439	247	67
8015	Crew Gold (Canada) Limited - Nugget Pond Facility	Baie Verte	–[(c)]	–	–	–	0.05	0.024	0.007
10222	Imperial Oil - Lewisporte Distribution Terminal	Lewisporte	–	–	–	199	–	–	–
5026	Municipality of Trinity Bay North - Incinerator	Port Union	–	54	–	18	31	22	20

Table 10.2.2-5 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Central and Eastern Newfoundland (continued)

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X [(a)]	VOCs	Total PM	PM_{10}	$PM_{2.5}$ [(b)]
8094	Newfoundland and Labrador Hydro - Charlottetown Diesel Generating Station	Charlottetown	–	–	107	–	–	–	–
8097	Newfoundland and Labrador Hydro - Little Bay Islands Diesel Generating Station	Little Bay Islands	–	–	49	–	–	–	–
8103	Newfoundland and Labrador Hydro - Ramea Diesel Generating Station	Ramea	–	–	187	–	–	–	–
5068	Newfoundland Transhipment Ltd. - Newfoundland Transhipment Terminal	Arnold's Cove	–	–	–	1,278	–	–	–
4316	North Atlantic Refining LP - North Atlantic Refining	Come by Chance	12,549	357	1,948	645	306	264	173
8084	Teck Resources Limited - Duck Pond Operations	Millertown	–	–	–	–	–	7.6	1.2
5024	Town of Bonavista - Incinerator	Bonavista	–	89	–	30	52	36	33
5025	Town of Burgeo - Burgeo Waste Disposal Site	Burgeo	–	31	–	10	–	13	12
5027	Town of Change Island - Incinerator	Change Island	–	–	–	–	–	2.5	2.3
5028	Town of Channel - Port aux Basques - Incinerator	Port aux Basques	–	136	–	46	80	56	52
5033	Town of Francois - Incinerator	Francois	–	–	–	–	–	1.1	1
5038	Town of King's Point - Incinerator	King's Point	–	–	–	–	–	5.7	5.2

Table 10.2.2-5 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Central and Eastern Newfoundland (continued)

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X [(a)]	VOCs	Total PM	PM_{10}	$PM_{2.5}$ [(b)]
5039	Town of Lourdes - Incinerator	Lourdes	–	77	–	26	45	32	29
5041	Town of McCallum - Incinerator	McCallum	–	–	–	–	–	1.1	1
5046	Town of Ramea - Ramea Waste Disposal Site	Ramea	–	–	–	–	–	5.1	4.7
5047	Town of Rencontre East - Incinerator	Rencontre East	–	–	–	–	–	1.4	1.3
5049	Town of St. George's - Incinerator	St. George's	–	85	–	28	49	35	32
5056	Town of Twillingate - Incinerator	Durrell	–	61	–	20	36	25	23
Total			**13,133**	**1,838**	**2,529**	**2,553**	**1,038**	**752**	**455**

Source: EC (2008b).
(a) NO_X as NO_2.
(b) Source EC (2008d, internet site).
(c) — = No data available.

Avalon Peninsula

Ten facilities on the Avalon Peninsula (Figure 10.2.2-1) reported CAC emissions. These facilities include waste incinerators, power plants, a food processing facility, a brewery, a petroleum terminal and a university (Table 10.2.2-6) (EC 2008b).

Table 10.2.2-6 National Pollutant Release Inventory – 2008 Reported Emissions of Criteria Air Contaminants – Avalon Peninsula

NPRI ID	Facility Name	City	Emissions (tonnes)						
			SO_2	CO	NO_X[a]	VOCs	Total PM	PM_{10}	$PM_{2.5}$[b]
6010	DND / Canadian Forest Service St. John's - Cambrai Rifle Range	Makinsons	–[c]	–	–	–	–	0.53	–
6035	Irving Oil - St. John's Terminal	St. John's	–	–	–	212	–	–	–
6050	Memorial University of Newfoundland - Main Campus Site, St. John's	St. John's	0.358	–	34	–	–	1.8	0.84
6048	Molson Canada - St. John's Brewery	St. John's	–	–	–	11	–	–	–
4882	Newfoundland and Labrador Hydro - Holyrood Thermal Generating Station	Holyrood	4,880	165	2,077	–	345	123	93
8106	Newfoundland and Labrador Hydro - Hardwoods Gas Turbine	St. John's	–	–	24	–	–	–	–
5043	Town of Old Perlican - Town of Old Perlican - Bay de Verde Incinerator	Old Perlican	–	83	–	28	49	34	32
5055	Town of Winterton - Winterton Incinerator and Landfill Site	Winterton	–	38	–	13	22	16	14
6087	Weston Bakeries Limited - Weston Bakeries Mount Pearl	Mount Pearl	–	–	–	24	–	–	–
Total			**4,880**	**286**	**2,135**	**288**	**416**	**178**	**142**

Source: EC (2008b).
[a] NO_x as NO_2.
[b] Source EC (2008d, internet site).
[c] — = No data available.

Summary

A comparison of the reported CAC emissions from facilities located in the five regions to the total for NL and Canada is presented in Table 10.2.2-7.

Table 10.2.2-7 Comparison of Criteria Air Contaminant Releases from Project Regions to Provincial and National Totals

Area	Emissions (tonnes)						
	SO_2	NO_X	CO	VOCs	PM	PM_{10}	$PM_{2.5}$
Total for Five Regions	18,293	5,394	2,301	3,275	1,516	986	648
Provincial Total	26,155	17,544	12,047	10,885	15,788	6,218	2,451
National Total	1,562,186	765,399	924,318	245,475	338,760	147,915	61,080
Emissions for Five Regions (% of National Emissions)	1.2	0.7	0.2	1.3	0.4	0.7	1.1
Provincial Emissions (% of National Emissions)	1.7	2.3	1.3	4.4	4.7	4.2	4.0

Source: EC (2010i, internet site), EC (2008b).

The emissions shown in Table 10.2.2-7 are not atypical of other provinces in Canada. For example, the provincial emissions of SO_2 are 1.7% of national emissions. Regional emissions of SO_2 range from 280 tonnes to 13,133 tonnes, with the highest emissions reported in Central and Eastern Newfoundland. The total emissions of air contaminants reported for the five regions crossed by the Project range from 0.2% to 1.3% of the total national emissions, suggesting that the emissions of air contaminants from these areas are relatively low.

10.2.2.4 Ambient Air Quality

The air quality in NL is also characterized by the ambient concentrations of specific air contaminants measured by monitoring stations in the National Air Pollution Surveillance Network. The ambient air quality in the five regions crossed by the Project is described in the following sections.

Central and Southeastern Labrador

Air quality in Central and Southeastern Labrador is representative of a clean environment (Table 10.2.2-8). EC operates an ambient monitoring station in Happy Valley-Goose Bay. The station is located in a residential area, and O_3 is the only air contaminant monitored. The 1-hour, 8-hour, and annual average ambient O_3 concentrations recorded at this station in 2006 are presented in Table 10.2.2-8 (EC 2008a, internet site).

Table 10.2.2-8 Ambient Ozone – Happy Valley-Goose Bay (2006)

Statistics for Recorded Values	Average Ambient Concentration ($\mu g/m^3$)		
	1-hour	8-hour	Annual
Maximum	133	128	–[a]
90^{th} percentile	86.4	86.4	–
Median	64.8	64.8	–
Average	–	–	62.8
Newfoundland and Labrador Max Permissible Concentration	160	87	–

Source: EC (2008a, internet site).
[a] — = Not Applicable.

In 2006, the 1-hour NL Maximum Permissible Concentration for O_3 was not exceeded; however, the 8-hour Maximum Permissible Concentration was exceeded. As shown in Table 10.2.2-1 (where the 90^{th} percentile of the measured 8-hour data is 86.4), approximately 10% of the 8-hour average ambient concentrations were over the NL 8-hour concentration limit.

The acceptable NAAQO (160 µg/m^3) for O_3 was not exceeded at this station in 2006. The value for comparison to the three-year O_3 Canada-Wide Standard is 106 µg/m^3, which is below the Canada-Wide Standard of 128 µg/m^3 (EC 2008a, internet site).

Information on SO_2, CO, NO_X and VOCs was not available for Central and Southeastern Labrador; however, based on the small number of substantive sources in the area, the ambient concentrations of SO_2, CO, NO_X and VOCs are likely to be low. Total suspended PM may be present in the ambient air due primarily to natural causes during specific events such as heavy winds or forest fires. During these events the concentrations of dust in the atmosphere may be elevated, otherwise the concentrations of dust are likely to be low.

As the concentrations of air contaminants are likely to be below the regulatory objectives most of the time, the air quality in Central and Southeastern Labrador is likely to be reflective of a clean environment.

Strait of Belle Isle

Air quality in the Strait of Belle Isle region is representative of a clean environment. There are no EC-operated air quality stations within the Strait of Belle Isle region. Since there are no substantive sources of air contaminants in the region, air quality here is influenced mainly by the long-range transport of airborne contaminants from upwind sources. However, when these air contaminants arrive in NL, the concentrations are likely to be low and typically below regulatory objectives on a frequent basis.

Northern Peninsula

The existing ambient air quality for the Northern Peninsula is good approximately 90% of the time (Table 10.2.2-9). During the remainder of the time, ambient air quality is typically fair, with a few occasions of poor air quality due to O_3. Two monitoring stations on the Northern Peninsula are located at Ferrole Point and Corner Brook, where O_3 is monitored. The 1-hour, 8-hour and annual average ambient concentrations of O_3 recorded at these stations in 2006 are presented in Table 10.2.2-9 and Table 10.2.2-10 (EC 2008a, internet site).

Table 10.2.2-9 Ambient Ozone – Ferrole Point (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	8-hour	Annual
Maximum	186	126	–[a]
90th percentile	96.2	94.2	–
Median	76.6	76.6	–
Average[b]	–	–	–
Newfoundland and Labrador Max Permissible Concentration	160	87	–

Source: EC (2008a, internet site).
[a] — = Not Applicable.
[b] Annual average O_3 concentration is not available (above data are based on nine months of data).

Table 10.2.2-10 Ambient Ozone – Corner Brook (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	8-hour	Annual
Maximum	139	114	–[a]
90th percentile	82.4	80.5	–
Median	51.0	51.0	–
Average	–	–	51.0
Newfoundland and Labrador Max Permissible Concentration	160	87	–

Source: EC (2008a, internet site).
[a] — = Not Applicable.

In 2006, the 1-hour and 8-hour NL Maximum Permissible Concentrations for O_3 for Ferrole Point were exceeded. Nearly 50% of the 8-hour average concentrations were over the NL 8-hour limit (EC 2008a, internet site; GNL 2004, internet site). The acceptable NAAQO (160 µg/m^3) for O_3 was exceeded twice at this station in 2006. A three-year average for comparison to the Canada-Wide Standard for O_3 was not available due to incomplete data sets in 2004 and 2006 (EC 2008a, internet site); however, in 2005 the value was 114 µg/m^3, which is below the Canada-Wide Standard of 128 µg/m^3.

In 2006, the 1-hour NL Maximum Permissible Concentration for O_3 for Corner Brook was not exceeded; however, the 8-hour Maximum Permissible Concentration was exceeded. Less than (<) 10% of the 8-hour average ambient concentrations were over the NL 8-hour concentration limit (Table 10.2.2-10).

The acceptable O_3 NAAQO (160 µg/m^3) was not exceeded at the Corner Brook station in 2006. The measured value for comparison to the three year O_3 Canada-Wide Standard is 104 µg/m^3, which is below the Canada-Wide Standard of 128 µg/m^3 (EC 2008a, internet site).

Information on SO_2, CO, NO_X and $PM_{2.5}$ was available for the Northern Peninsula. One National Air Pollution Surveillance monitor is located in the Northern Peninsula at Corner Brook. The Corner Brook monitoring station records ambient concentrations of SO_2, NO_x, CO, $PM_{2.5}$ and O_3.

The Corner Brook station is located approximately 1 km from the Corner Brook Pulp and Paper mill. Other substantive sources of air contaminants are petroleum terminals. The average ambient concentrations of SO_2, NO_2, CO and $PM_{2.5}$ recorded at the Corner Brook station in 2006 are presented in Table 10.2.2-11, Table 10.2.2-12, Table 10.2.2-13 and Table 10.2.2-14, respectively (EC 2008a, internet site).

The existing ambient air quality in the Northern Peninsula region of Newfoundland is good more than 90% of the time (Table 10.2.2-11 to Table 10.2.2-14). During the remainder of the time, ambient air quality is fair.

Table 10.2.2-11 Ambient Sulphur Dioxide – Corner Brook (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	24-hour	Annual
Maximum	50	31	–[a]
90th percentile	18.3	18.3	–
Median	7.9	7.9	–
Average[b]	–	–	–
Newfoundland and Labrador Max Permissible Concentration	900	300	60

Source: EC (2008a, internet site).
[a] — = Not Applicable.
[b] Annual average SO_2 concentration is not available (above data is based on seven months of data).

Table 10.2.2-12 Ambient Nitrogen Dioxide – Corner Brook (2006)

Statistics for Recorded Values	Average Ambient Concentration (μg/m^3)		
	1-hour	24-hour	Annual
Maximum	72	32	–[a]
90th percentile	11.3	9.4	–
Median	1.9	3.8	–
Average	–	–	3.8
Newfoundland and Labrador Max Permissible Concentration	400	200	100

Source: EC (2008a, internet site).
[a] — = Not Applicable.

Table 10.2.2-13 Ambient Carbon Monoxide – Corner Brook (2006)

Statistics for Recorded Values	Average Ambient Concentration (μg/m^3)		
	1-hour	8-hour	Annual
Maximum	1,145	916	–[a]
90th percentile	458	458	–
Median	344	344	–
Average[b]	–	–	–
Newfoundland and Labrador Max Permissible Concentration	35,000	15,000	–

Source: EC (2008a, internet site).
[a] — =Not Applicable.
[b] Annual average CO concentration is not available (above data is based on ten months of data).

Table 10.2.2-14 Ambient $PM_{2.5}$ – Corner Brook (2006)

Statistics for Recorded Values	Average Ambient Concentration (μg/m^3)		
	1-hour	24-hour	Annual
Maximum	44	20	–[a]
90th percentile	8.0	7.0	–
Median	3.0	3.0	–
Average	–	–	4.0
Newfoundland and Labrador Max Permissible Concentration	–	25	–

Source: EC (2008a, internet site).
[a] — = Not Applicable.

The maximum ambient air concentrations of SO_2, NO_2, and CO were below their respective NL Maximum Permissible Concentrations and the maximum desirable NAAQO. The value for comparison to the three year $PM_{2.5}$ Canada-Wide Standard is 11 μg/m^3, which is below the Canada-Wide Standard of 30 μg/m^3 (EC 2008a, internet site).

Central and Eastern Newfoundland

One National Air Pollution Surveillance monitor is located in Central and Eastern Newfoundland at Grand Falls-Windsor. Only O_3 is monitored at the Grand Falls-Windsor station.

Other substantive sources of air contaminants are petroleum terminals. The Grand Falls-Windsor station is located approximately 3 km to the east of the Abitibi-Consolidated Grand Falls pulp and paper mill.

The 1-hour, 8-hour, and annual ambient concentrations of O_3 recorded at the Grand Falls-Windsor station in 2006 are presented in Table 10.2.2-15 (EC 2008a, internet site).

Table 10.2.2-15 Ambient Ozone – Grand Falls-Windsor (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	8-hour	Annual
Maximum	122	112	–[(a)]
90th percentile	78.5	78.5	–
Median	55.0	55.0	–
Average	–	–	55.0
Newfoundland and Labrador Max Permissible Concentration	160	87	–

Source: EC (2008a, internet site).
(a) — = Not Applicable.

In 2006, the 1-hour NL Maximum Permissible Concentration for O_3 was not exceeded; however, the 8-hour Maximum Permissible Concentration was exceeded. As shown in Table 10.2.2-15 (where the 90th percentile of the measured 8-hour data is 78.5), <10% of the 8-hour average ambient concentrations were over the NL 8-hour concentration limit.

The acceptable NAAQO (160 µg/m^3) was not exceeded at the Grand Falls-Windsor station in 2006 (EC 2008a, internet site). The value for comparison to the three year O_3 Canada-Wide Standard is 108 µg/m^3, which is below the Canada-Wide Standard of 128 µg/m^3 (EC 2008a, internet site).

Avalon Peninsula

The existing ambient air quality for the Avalon Peninsula is good more than 90% of the time (Table 10.2.2-16 to Table 10.2.2-25). During the remainder of the time, ambient air quality is fair. There are two National Air Pollution Surveillance monitors located on the Avalon Peninsula, one in St. John's and the other in Mount Pearl. At both of these stations, the ambient concentrations of SO_2, NO_2, CO, $PM_{2.5}$ and O_3 are measured. The St. John's station is located in a predominately commercial area, whereas the Mount Pearl station is located in a residential area.

The average ambient concentrations of SO_2, NO_2, CO and $PM_{2.5}$ recorded at the St. John's station in 2006 are presented in Table 10.2.2-16, Table 10.2.2-17, Table 10.2.2-18 and Table 10.2.2-19 (EC 2008a, internet site).

Table 10.2.2-16 Ambient Sulphur Dioxide – St. John's (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	24-hour	Annual
Maximum	37	8	–[a]
90th percentile	5.2	5.2	–
Median	2.6	2.6	–
Average	–	–	2.6
Newfoundland and Labrador Max Permissible Concentration	900	300	60

Source: EC (2008a, internet site).
[a] — = Not Applicable.

Table 10.2.2-17 Ambient Nitrogen Dioxide – St. John's (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	24-hour	Annual
Maximum	90	41	–[a]
90th percentile	24.5	20.7	–
Median	9.4	9.4	–
Average	–	–	11.3
Newfoundland and Labrador Max Permissible Concentration	400	200	100

Source: EC (2008a, internet site).
[a] — = Not Applicable.

Table 10.2.2-18 Ambient Carbon Monoxide – St. John's (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	8-hour	Annual
Maximum	4,008	1,145	–[a]
90th percentile	344	344	–
Median	229	229	–
Average	–	–	229
Newfoundland and Labrador Max Permissible Concentration	35,000	15,000	–

Source: EC (2008a, internet site).
[a] — = Not Applicable.

Table 10.2.2-19 Ambient $PM_{2.5}$ – St. John's (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	24-hour	Annual
Maximum	53	13	–[(a)]
90th percentile	8.0	6.0	–
Median	3.0	4.0	–
Average	–	–	4.0
Newfoundland and Labrador Max Permissible Concentration	–	25	–

Source: EC (2008a, internet site).
(a) — = Not Applicable.

The maximum ambient air concentrations of SO_2, NO_2 and CO were below their respective NL Maximum Permissible Concentrations and the maximum desirable NAAQO in 2006. The maximum 24-hour average $PM_{2.5}$ concentration was below the NL Maximum Permissible Concentration. The value for comparison to the three year $PM_{2.5}$ Canada-Wide Standard is 9 µg/m^3, which is below the Canada-Wide Standard of 30 µg/m^3 (EC 2008a, internet site).

The 1-hour, 8-hour, and annual ambient concentrations of O_3 recorded at the St. John's station in 2006 are presented in Table 10.2.2-20 (EC 2008a, internet site).

Table 10.2.2-20 Ambient Ozone – St. John's (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	8-hour	Annual
Maximum	137	126	–[(a)]
90th percentile	74.6	76.6	–
Median	53.0	53.0	–
Average	–	–	53.0
Newfoundland and Labrador Max Permissible Concentration	160	87	–

Source: EC (2008a, internet site).
(a) — = Not Applicable.

In 2006, the 1-hour NL Maximum Permissible Concentration for O_3 was not exceeded; however, the 8-hour Maximum Permissible Concentration was exceeded. As shown in Table 10.2.2-20 (where the 90th percentile of the measured 8-hour data is 76.6), <10% of the 8-hour average ambient concentrations were over the NL 8-hour concentration limit (EC 2008a, internet site; GNL 2004, internet site).

The acceptable O_3 NAAQO (160 µg/m^3) was not exceeded at this station in 2006. The value for comparison to the three year O_3 Canada-Wide Standard is 108 µg/m^3, which is below the Canada-Wide Standard of 128 µg/m^3 (EC 2008a, internet site). The average ambient concentrations of SO_2, NO_2, CO and $PM_{2.5}$ recorded at the Mount Pearl station in 2006 are presented in Table 10.2.2-21, Table 10.2.2-22, Table 10.2.2-23 and Table 10.2.2-24 (EC 2008a, internet site).

Table 10.2.2-21 Ambient Sulphur Dioxide – Mount Pearl (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	24-hour	Annual
Maximum	37	13	–[(a)]
90th percentile	5.2	5.2	–
Median	2.6	2.6	–
Average	–	–	2.6
Newfoundland and Labrador Max Permissible Concentration	900	300	60

Source: EC (2008a, internet site).
(a) — = Not Applicable.

Table 10.2.2-22 Ambient Nitrogen Dioxide – Mount Pearl (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	24-hour	Annual
Maximum	68	23	–[(a)]
90th percentile	5.6	5.6	–
Median	1.9	1.9	–
Average	–	–	3.8
Newfoundland and Labrador Max Permissible Concentration	400	200	100

Source: EC (2008a, internet site).
(a) — = Not Applicable.

Table 10.2.2-23 Ambient Carbon Monoxide – Mount Pearl (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m^3)		
	1-hour	8-hour	Annual
Maximum	2,634	1,603	–[(a)]
90th percentile	802	802	–
Median	344	344	–
Average	–	–	458
Newfoundland and Labrador Max Permissible Concentration	35,000	15,000	–

Source: EC (2008a, internet site).
(a) — = Not Applicable.

Table 10.2.2-24 Ambient $PM_{2.5}$ – Mount Pearl (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	24-hour	Annual
Maximum	139	31	–[(a)]
90th percentile	6.0	5.0	–
Median	2.0	3.0	–
Average	–	–	3.0
Newfoundland and Labrador Max Permissible Concentration	–	25	–

Source: EC (2008a, internet site).
(a) — = Not Applicable.

The maximum ambient air concentrations of SO_2, NO_2 and CO were below their respective NL Maximum Permissible Concentrations. The maximum 24-hour average $PM_{2.5}$ concentration exceeded the NL Maximum Permissible Concentration.

As shown in Table 10.2.2-24, few of the 24-hour average ambient concentrations were over the NL 24-hour concentration limit. The value for comparison to the three year $PM_{2.5}$ Canada-Wide Standard is 9 µg/m³, which is below the Canada-Wide Standard of 30 µg/m³ (EC 2008a, internet site).

The 1-hour, 8-hour, and annual ambient concentrations of O_3 recorded at the Mount Pearl station in 2006 are presented in Table 10.2.2-25 (EC 2008a, internet site).

Table 10.2.2-25 Ambient Ozone – Mount Pearl (2006)

Statistics for Recorded Values	Average Ambient Concentration (µg/m³)		
	1-hour	8-hour	Annual
Maximum	147	139	–[(a)]
90th percentile	84.4	82.4	–
Median	66.7	66.7	–
Average	–	–	64.8
Newfoundland and Labrador Max Permissible Concentration	160	87	–

Source: EC (2008a, internet site).
(a) — = Not Applicable.

In 2006, the 1-hour NL Maximum Permissible Concentration for O_3 was not exceeded; however, the 8-hour Maximum Permissible Concentration was exceeded. The acceptable O_3 NAAQO (160 µg/m³) was not exceeded at this station in 2006. The value for comparison to the three year O_3 Canada-Wide Standard is 102 µg/m³, which is below the Canada-Wide Standard of 128 µg/m³ (EC 2008a, internet site).

Summary

Based on the information presented for each of the five regions, air quality in NL is representative of that typically found in a rural and clean environment. As shown in Figure 10.2.2-1, the transmission corridor through the Avalon Peninsula is in proximity to emission sources, primarily in the western and eastern portions of this region. As a result, the existing ambient air quality in the Avalon Peninsula is good more than 90% of the time. During the remainder of the time, ambient air quality is fair (based on the AQI developed by the Government of New Brunswick (2009)). While there may be a difference in air quality on the Avalon Peninsula relative to other regions, this difference is slight and occurs for only a small portion of the year. As a result, the difference in ambient air quality between each of the five regions is not substantive.

10.2.3 Ambient Sound Levels

In describing the existing environment for ambient sound levels, two types of areas are considered: (i) wilderness and remote environments; and (ii) areas close to communities and infrastructure. Ambient noise in remote areas considers the sounds of nature to be dominant, while areas closer to communities and infrastructure are dominated by sounds from traffic and anthropogenic activities. Ambient sound levels are discussed in terms of frequencies associated with human hearing.

10.2.3.1 Study Area

The existing baseline conditions for the ambient sound levels are presented in relation to the proposed 2 km wide transmission corridor from Central Labrador to the Island of Newfoundland's Avalon Peninsula and a buffer extending 1 km wide on each side to comprise the Study Area, as well as considering the location of other Project-related components and activities (Figure 10.2.1-1).

10.2.3.2 Information Sources and Data Collection

Studies on ambient sound levels in remote areas of NL are not common, with the exception of extensive research within the military training area associated with 5 Wing Goose Bay (e.g., Baker and Belliveau 2001; Standen et al. 1998; Trimper et al. 1998a, b). A common approach when describing ambient sound levels in rural or remote areas is to assume that background levels are dominated by the sounds of nature, such as wind in the trees. In Alberta (and later adopted in British Columbia), the energy permitting agencies (i.e., Energy Resources Conservation Board (ERCB) (ERCB 2007)) have adopted default levels for background sound that are the result of several sampling programs. Based on the similarity of the landscapes of variable boreal forest, and professional experience within similar environments by the Atmospheric Environment Study Team, it was concluded that the assumed ambient levels, such as implemented in western Canada, are representative of the ambient sound levels in the Study Area.

Publicly available information and professional judgment were used to qualitatively describe the likely ambient sound levels in the regions, thus obviating the need to conduct field work. This is based on previous experience with similar projects in locations similar to those crossed by the Project. Note that noise levels are described in terms of decibels (dB) and expressed as A-weighted (dBA), assessing frequencies associated with the hearing of human beings.

10.2.3.3 Ambient Sound Levels

In the wilderness and remote areas that constitute the majority of the regions crossed by the transmission corridor and other Project components, the sound environment is likely to be dominated by:

- the sound of wind in the trees and vegetation;
- the sound of running water in the vicinity of streams or rivers; and
- animal sounds.

The transmission corridor overlaps with, or lies close enough to, residences, communities or infrastructure and the ambient sound level may be influenced by a range of sounds such as:

- traffic, the main component of the "hum" in urban areas;
- sounds of construction;
- sounds from airplanes;

- sounds from logging and / or agricultural activities;
- workplace sounds such as service stations or workshops; and
- recreational sounds from sports fields or similar facilities.

Measured and modelled ambient noise levels in areas of Central and Southeastern Labrador within and adjacent to the military training area for 5 Wing Goose Bay range from 35 to 45 dBA, depending on wind conditions and time of day (Nalcor 2009; Trimper et al. 2003; Trimper et al. 1998a, b). For other areas of Labrador and Newfoundland in the Study Area, the information available from the Alberta ERCB for locations in Alberta are considered to be similar to those crossed by the Project. The ERCB found that background natural sounds in a rural environment were typically approximately 35 dBA during the night (23:00 to 07:00) and approximately 45 dBA during the day, due to increased wind activity and animal sounds (ERCB 2007). Professional experience confirms this range, although rare, extremely quiet, still nights may result in minimum levels under 30 dBA, while herpetiles such as spring peepers can cause local sound levels of over 60 dBA at night.

In terms of anthropogenic sources, military aircraft overflights within the training area in Central and Southeastern Labrador can result in short-term (less than a few seconds) noise events in excess of 100 dB (Trimper et al. 1998a). Elsewhere in the Study Area in the vicinity of human settlements, ambient sound levels are likely to be in the order of 40 dBA at night and 50 dBA during the day, although the proximity of arterial road traffic and industrial activity can increase levels by 5 dBA or more depending on the activity at the location, wind, terrain and distance to these sources (ERCB 2007).

In general, the ambient sound levels increase in the vicinity of villages, towns and highways within and along the transmission corridor, due to the increase in populations of these centres; however, sound is localized, and the majority of the route is remote from human presence. Ambient sound levels will be lowest for the locations along the transmission corridor that are rural or remote and where there is little vehicle traffic.

Ambient sound levels for much of NL are dominated by the sounds of nature, predominantly wind effects on vegetation, with local modification by animal sounds or the sounds of running water. Background levels in such environments are low-level, but variable, ranging, based on professional experience, from levels as low as 25 dBA to approximately 40 dBA. It is because wind is the dominant noise generator that the ambient sound level is so variable. The variability across the five regions is no greater than the variability within a region due to changing meteorology; however, these ambient sound levels are lower than the levels that would be considered intrusive and potentially disturbing.

10.3 Terrestrial Environment

As the Project traverses approximately 1,100 km from Muskrat Falls in Central Labrador to Soldiers Pond on the Avalon Peninsula, the Terrestrial Environment includes a diversity of geological formations, vegetation and animals. The existing Terrestrial Environment describes the geology (both bedrock and surficial) and geomorphology. The existing vegetation environment includes an ecological land classification, wetland classification, regionally uncommon potential mapping, timber resources, and consideration of listed species in the Project area. The existing Terrestrial Environment also describes the baseline conditions for the following species: caribou, moose and black bear, furbearers and small mammals, and avifauna.

10.3.1 Geology (Bedrock)

The existing environment for geology (bedrock) is presented for the entire province. For Labrador this includes a discussion of the Grenville Province, and for the Island of Newfoundland, the tectonic zones of the Humber, Dunnage, Gander and Avalon. The various rock types and various processes that have acted upon these formations in the past are also discussed in this section.

10.3.1.1 Study Area

The Study Area for geology (bedrock) is the Province of NL (Figure 10.3.1-1 and Figure 10.3.1-2) due to the extensive nature of the formations.

10.3.1.2 Information Sources and Data Collection

Available data and published literature have been used in preparing the description of the existing geology (bedrock), including sources of information from government agencies, academia, research organizations and technical sources of scientific data relating to geology in NL.

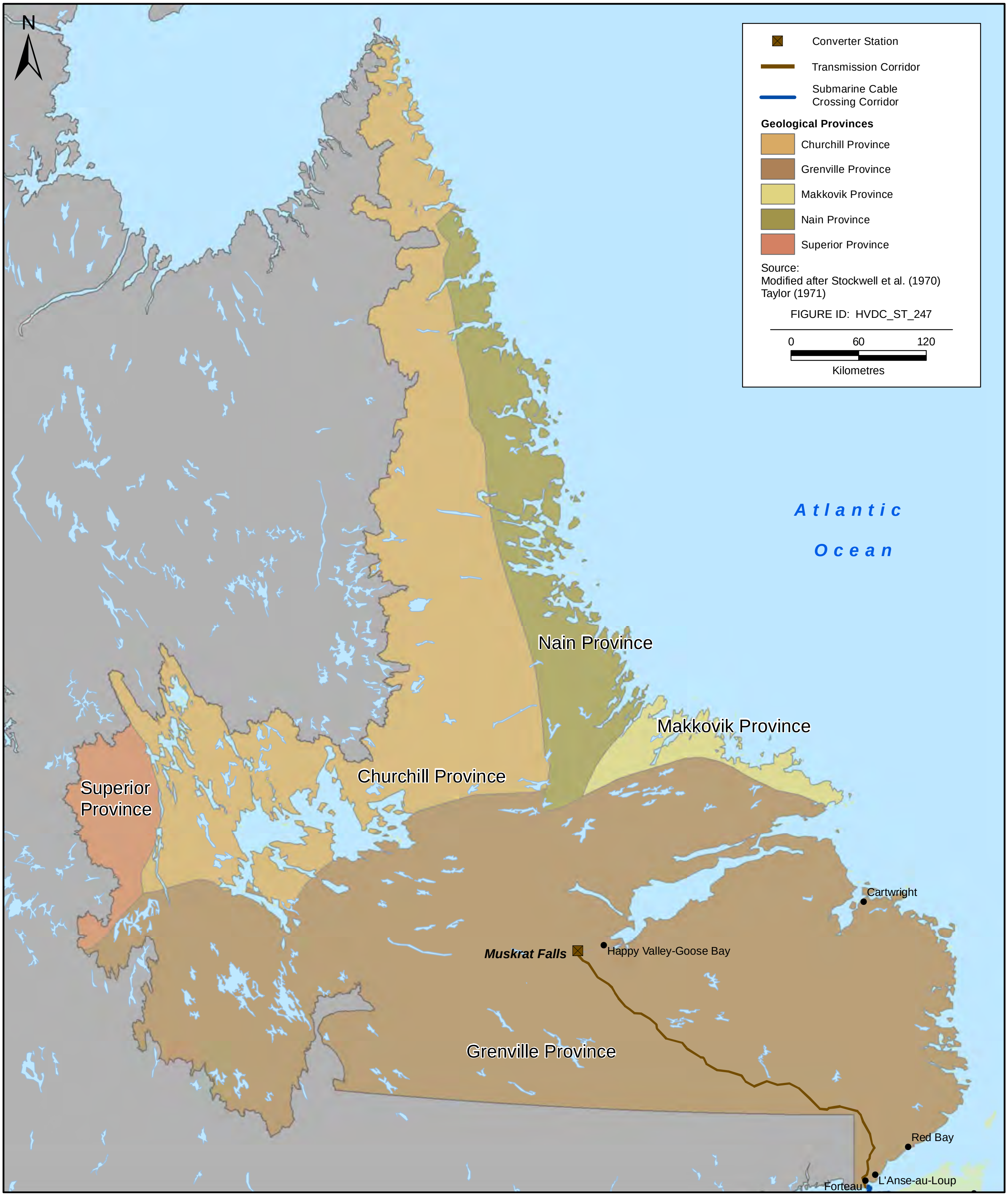
10.3.1.3 Description of Geology (Bedrock)

Labrador

The transmission corridor in Central and Southeastern Labrador is approximately 400 km in length from Muskrat Falls to the Strait of Belle Isle. It primarily crosses intrusive anorthosites and massive granitic rocks. The transmission corridor within Labrador is predominantly underlain at depth by intrusive igneous and metamorphic rocks of the tectonic Grenville Province (Figure 10.3.1-1) that are Proterozoic to Precambrian in age and forming the easternmost part of the expansive Canadian Shield (Ryan 1989). Unconformably overlying these ancient rocks, are younger less deformed volcanic and sedimentary sequences.

Locally, within the immediate area of Muskrat Falls, arkose and conglomerate sedimentary rocks of the Double Mer Formation that are late Proterozoic in age, overlay the intrusive rocks. The Double Mer Formation is a continental deposit in which a massive amount of material accumulated quickly in a rift valley in a south-west to north-east trend encompassing the south-western portion of Lake Melville (Gower 1986).

On the Labrador side of the Strait of Belle Isle, between the towns of Forteau and L'Anse-au-Loup, sedimentary and carbonate facies rocks that are Cambrian in age, outcrop at the surface. These rocks are contained within the Humber Tectonic Zone that also occurs in Newfoundland, and are believed to be the remnants of an earlier oceanic event (Ryan 1989).



nalcor energy

FIGURE 10.3.1-1

Structural Geological Provinces of Labrador

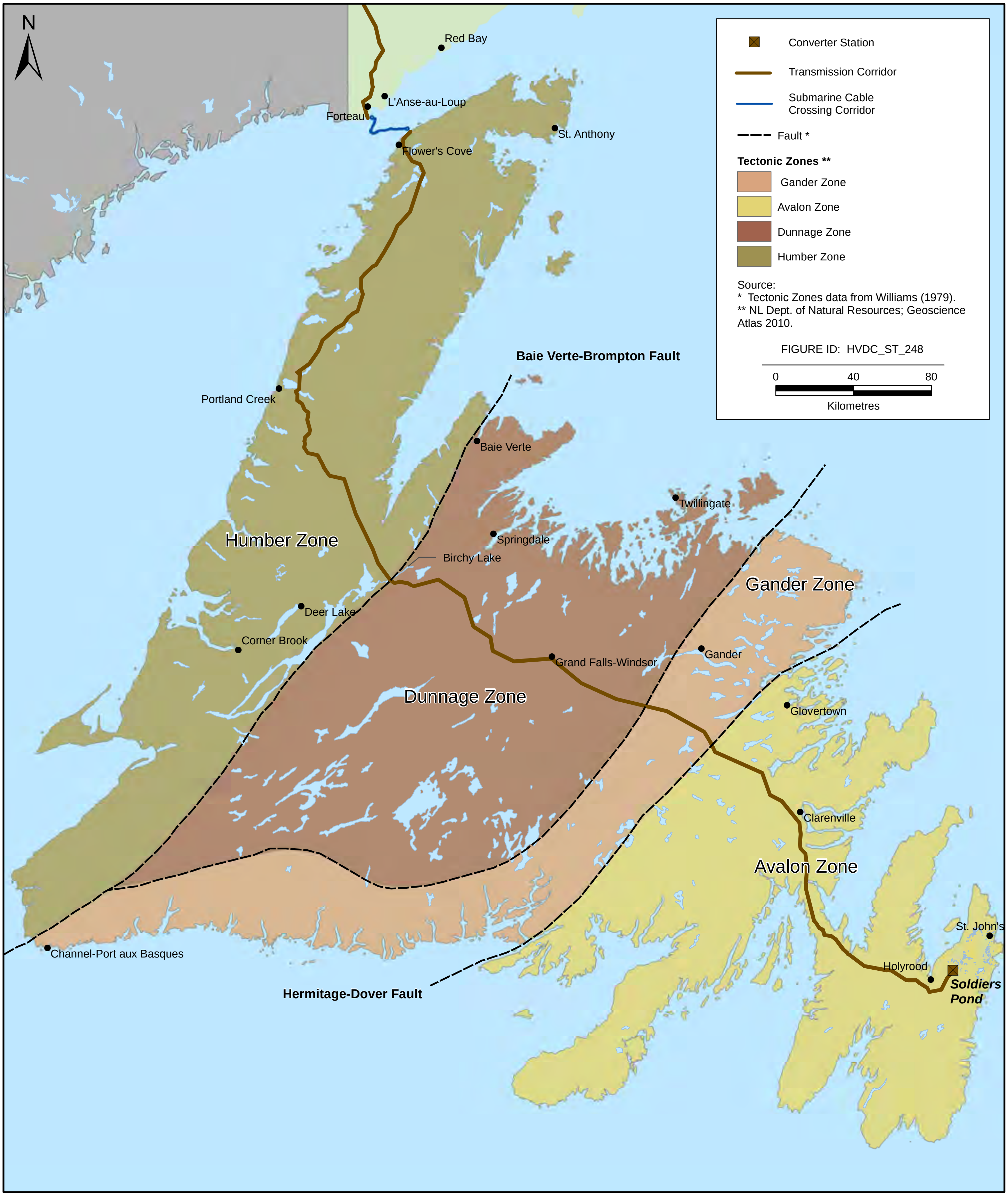


FIGURE 10.3.1-2

Tectonic Zones of Newfoundland

Newfoundland

The transmission corridor crosses all four of the tectonic zones of Newfoundland (Figure 10.3.1-2). These tectonic zones are identified from west to east as the Humber, Dunnage, Gander and Avalon Zones (Williams 1979) and range from Cambrian to Devonian in age. Regionally, the boundaries between the various zones trend in a south-west to north-east direction across Newfoundland. These sometimes complex zones, and their associated rocks, are the result of the closure of an ancient ocean known as Iapetus Ocean during the late-Precambrian to the mid-Silurian periods (Handcock and Skinner 2000).

Humber Zone

Prior to 600 million years ago, North America formed part of a much larger megacontinent. The Humber Zone has been identified as belonging to part of this ancient North American plate (Hodych et al. 1989). It extends from the Strait of Belle Isle (including outcrops on the Labrador side) eastward to the Birchy Lake region in central Newfoundland. The rocks in the Humber Zone represent the eastern edge of North America of the early Paleozoic period and the easternmost rocks in this Zone are the westernmost edge of the ancient lapetus Ocean.

Within the Humber Zone, rocks of the western and northern portions of the present-day Northern Peninsula were formed in shallow marine environments at sub-equatorial latitudes (Hodych et al. 1989; Knight 1989). As a result, they generally comprise carbonate rocks, principally limestone and dolomite. The proposed transmission corridor from the Strait of Belle Isle, extends southward for approximately 200 km to the area around Portland Creek, traversing these carbonate rocks.

The central and eastern portions of the Northern Peninsula form part of the 3,500 km long Appalachian Mountains chain, Precambrian in age, extending from Newfoundland to the south-eastern portion of the United States (King 1989). As the transmission corridor crosses the Northern Peninsula from the area around Portland Creek south-eastward, it traverses metamorphosed schists and gneisses comprising the present-day Long Range Mountains. These mountains are situated primarily within and north of Gros Morne National Park reaching heights in excess of 800 m. Present within these rocks, particularly in the east, are younger granitic intrusives. This portion of the transmission corridor is approximately 60 km in length.

Unconformably overlying these metamorphic and igneous rocks to the east are sedimentary sequences of the Deer Lake Basin (Hyde 1989). These rocks are identified as containing primarily sandstones and shales, are Carboniferous in age and were deposited in localized lowlands during the formation of inland lakes and are therefore generally fluvial and alluvial in origin. Outcropping between sedimentary rocks of the Deer Lake Basin and the Baie Verte Lineament (a major steeply dipping structural belt) is a complex of intensely metamorphosed sedimentary rocks described predominantly as schists and gneisses (Hibbard 1989). The transmission corridor across this easternmost portion of the Humber Tectonic Zone is approximately 60 km in length.

Dunnage Zone

The transmission corridor traverses the Dunnage Tectonic Zone in a south-east to north-west trend as shown in Figure 10.3.1-2 for approximately 180 km. The area comprising the Dunnage Zone stretches from approximately the eastern end of Birchy Lake to just west of Gander in central Newfoundland, crossing Gander Lake in the east. It is often referred to as the Central Mobile Belt. The Dunnage Zone was formed between the Late Cambrian to Carboniferous periods. The western boundary of the Dunnage Zone, and hence the eastern boundary of the Humber Zone, is defined along a major south-west to north-east trending fault (the Baie Verte-Brompton Fault) within the Baie Verte Lineament, extending from the south-west corner of Newfoundland, northward to the town of Baie Verte, essentially following the Baie Verte Highway within the transmission corridor (Hibbard 1989). On the Baie Verte Peninsula, rocks found east of this fault fundamentally differ from those located west of the fault. Those to the east typically comprise rocks of volcanic origin and intrusives that have not been subjected to intense metamorphic events. At several locations on the Baie Verte

Peninsula, evidence of the ancient Iapetus Ocean is present. Obduction of the oceanic crust occurs in the form of an ophiolite suite with remnants of this complex outcropping on the Baie Verte Peninsula, in the Springdale area of Green Bay and on Twillingate Island in Notre Dame Bay (Kean 1989).

East of the Baie Verte Peninsula extending towards the Gander Zone, rocks representing the Dunnage Zone are believed to represent intense volcanic activities during the closure of Iapetus Ocean. During this period, subduction of the ancient oceanic crust occurred creating volcanic island arcs. Subsequent erosion of these volcanic arcs generated large deposits of sedimentary rocks such as sandstones, shales and conglomerates. Post-volcanic activity resulted in the intrusion of both mafic and felsic rocks as occurs throughout the Dunnage Zone and represented by basalts, pillow lavas, granites, gabbros and syenites (Kean 1989; Williams 1979). Mining of base metals has been taking place throughout the Dunnage Zone for well over 100 years. Minerals such as gold, copper, lead and zinc are known to occur in rocks of volcanic origin.

Gander Zone

The area encompassing the Gander Zone, trending in a south-west to north-east direction, extends from just west of the town of Gander, eastward, to Glovertown (Blackwood 1989). The western boundary of the Gander Zone is defined by a narrow, truncated band of ultramafic rocks emplaced along the faulted zone and known as the Gander River Ultramafic Belt. This band of essentially unaltered rocks comprises gabbroic and mafic volcaniclastic and felsic plutonic units rich in pyroxene (Blackwood 1989). Ultramafic rocks are defined as intrusive rocks that contain <10% lighter-coloured minerals such as quartz and feldspar. To the east, the boundary is marked by a fault known as the Dover-Hermitage Bay Fault. Rocks of the Gander Zone are considered to be Lower Ordovician to Devonian in age (Hodych et. al., 1989).

Rocks of the western portion of the Gander Zone are described as an assemblage of metasedimentary rocks (Blackwood 1989). Within these areas are minor conglomerates, greywackes and basic volcanics. A strong schistocity is developed in these metasediments and minor folding is evident. The degree of metamorphism ranges from greenschist to lower amphibolite facies.

East of these metasediments, a mixture of metamorphic and igneous rocks known as paragneisses and migmitites are predominant. The degree of metamorphism and deformation within these rocks increases from west to east resulting in complex structural deformational patterns on a regional scale (Blackwood 1989). The transmission corridor across the Gander Zone is approximately 45 km in length.

Avalon Zone

The easternmost tectonic zone that the proposed transmission corridor traverses is the Avalon Zone a region consisting mainly of thick sequences of Precambrian volcanic and sedimentary rocks locally overlain by Paleozoic fossiliferous sedimentary units (King 1989). It extends from the Dover-Hermitage Bay Fault in the west, near the community of Glovertown, to at least 250 km east beyond the city of St. John's onto the present-day continental shelf. The approximate length of the transmission corridor as it crosses the Avalon Zone where it terminates at Soldiers Pond is 200 km.

The geology of the Avalon Peninsula suggests a long history of volcanism, marine and terrestrial sedimentation, tectonic uplift and subsidence of a major depositional basin (King 1989). Geologically, it is characterized by thick sequences of volcanic activity producing volcanic islands generating shallow inland marine environments followed by the development of lakes and rivers.

The westernmost portion of the Avalon Zone comprises sandstones, conglomerates and shales either unconformably overlying or adjacent to thick bimodal and subaerial volcanic sequences which are present through the Isthmus of the Avalon Peninsula (King 1989). Also present in this area are rocks formed in a deep marine environment comprised of highly siliceous siltstones and sandstones.

Successively, sandstones, conglomerates and shales found in the western portion of the Avalon Zone appear again east of the Isthmus of the Avalon Peninsula (King 1989). This geographically wide group of rocks is penetrated midway by zones of Paleozoic rocks described as siliciclastic sedimentary units. East of the sedimentary units are sequences of fluvial and marine sedimentary rocks that are subdivided into further sequences of tuffaceous sandstones, arkosic sandstones, conglomerates and thin occurrences of mudstones.

To the east of these sedimentary units are volcanic rocks that include andesites, rhyolites, basalts, tuffs and ignimbrites (King 1989). The origin of these rocks is indicative of periodic violent and explosive volcanic activity.

Intruding within these volcanics, is a plutonic granitoid referred to as the Holyrood Batholith (King 1989) that may exist at the eastern end of the proposed transmission corridor at Soldiers Pond.

10.3.2 Geology (Surficial) and Geomorphology

Newfoundland and Labrador experienced numerous glaciation events during the late Cenozoic era, resulting in the erosion of bedrock and unconsolidated soils, and the subsequent deposition and redeposition of soils (Rogerson 1989). Evidence of earlier glaciations generally does not survive the most recent event. The exceptions would be, for instance, in mountainous terrain where higher elevations may have escaped more recent glacial events and on the leeward side of resistant features. Therefore, the most recent glaciation during the Late Wisconsin era, resulted in the formation of the present-day landforms. Although it is widely believed that the last major glacial event in NL occurred some 12,000 years ago, the extent of glaciation is not fully understood.

10.3.2.1 Study Areas

The Study Area for geology (surficial) and geomorphology is the Province of NL (Figure 10.3.2-1 and Figure 10.3.2-2) due to the extensive nature of the formations.

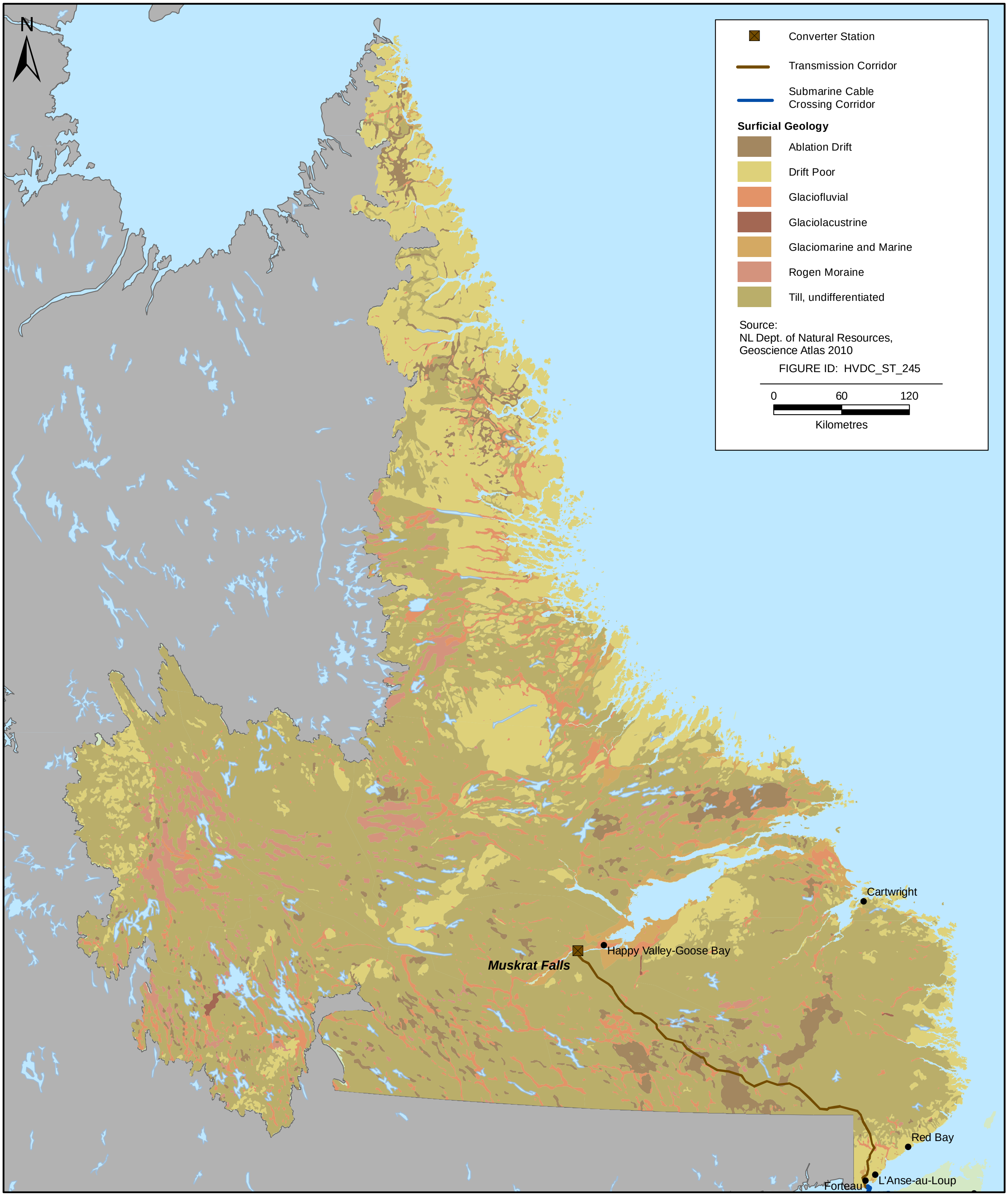
10.3.2.2 Information Sources and Data Collection

Available data and published literature have been used in preparing the description of the existing geology, including sources of information from government agencies, academia, research organizations and technical sources of scientific data relating to geology and geomorphology in NL.

10.3.2.3 Description of Geology (Surficial) and Geomorphology

Labrador

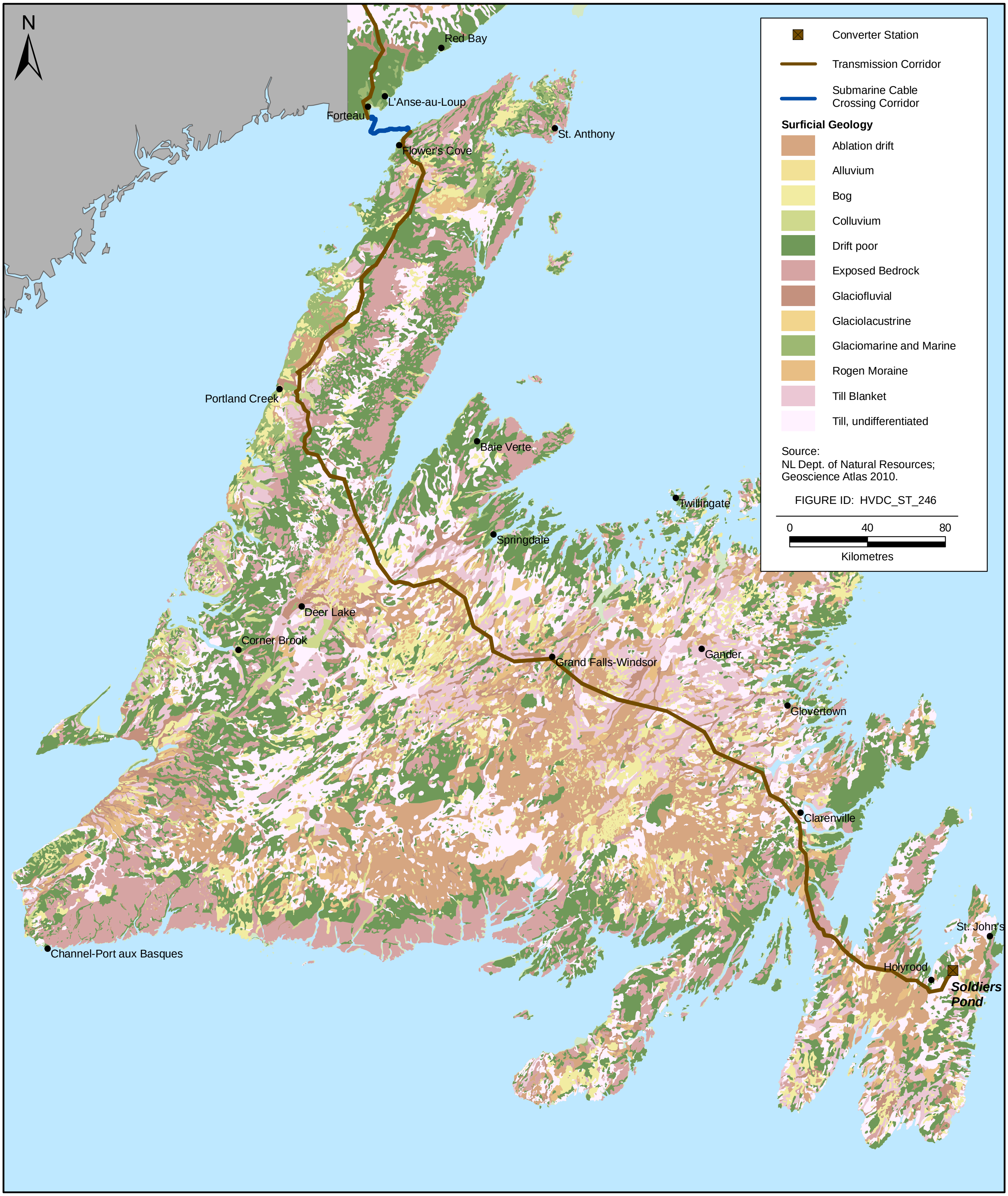
In the immediate vicinity of Muskrat Falls in Labrador, the proposed transmission corridor crosses unconsolidated, moderately thick glaciomarine and marine deposits (Rogerson 1989). Extending from these limits, south-eastward along the transmission corridor towards the Strait of Belle Isle, undifferentiated deposits of till dominate the landscape. Locally, these deposits can be up to 7 m thick. However, as the corridor approaches the Strait of Belle Isle, the bedrock exposure dominates with minimal overburden cover. Glacial features such as drumlins and eskers are frequent. Drumlins are glacial deposits of sands and gravels that can be several tens to hundreds of metres in height, length and width. Their long axis generally reflects the direction of ice movement. Eskers are similar to drumlins in that they are glacial deposits of sands and gravels (poorly sorted, in the case of eskers). They are not generally as high as drumlins, but instead have a relief of 3 to 15 m (Liverman and Taylor 1990) with steep slopes, are sinuous in appearance, and can be up to 10 km. They form perpendicular to ice margins. The orientation of these features in southern Labrador suggests the movement of ice during the most recent glacial event to be in a north-west to south-east direction.



nalcor energy

FIGURE 10.3.2-1

Surficial Geology of Labrador



nalcor energy

FIGURE 10.3.2-2

Surficial Geology of Newfoundland

Approximately two-thirds of the distance between Muskrat Falls and the Strait of Belle Isle, the transmission corridor crosses a glaciofluvial feature referred to as the Paradise Moraine. This feature suggests the maximum extent of the last glaciation in south-eastern Labrador (Rogerson 1989). These morainal deposits are dominantly sandy and gravelly basal (lodgment) till that are further subdivided into four classes: (i) till and minor sand and gravel of variable thickness; (ii) basal (lodgement) till and minor sand, gravel, and finer materials generally 1 to 10 m thick; (iii) gently rolling surface (ground moraine) with indications of drumlinoid moraine; and (iv) basal (lodgement) till veneering rock that is generally <1 m thick (Jacques Whitford and Innu 2003). As the transmission corridor approaches the Strait of Belle Isle to within approximately 40 km of the coast, glacial drift dominates as more outcropping of the underlying bedrock is exposed (Figure 10.3.2-1).

Permafrost occurs when the ground remains at or below a temperature of 0°C for a minimum of two years (Natural Resources Canada (NRCan) 2011, internet site). In Labrador, the majority of the Project components (i.e., all but the Project components along the Strait of Belle Isle and inland approximately 20 km) will cross lands classified as supporting isolated patches of permafrost (0 to 10%). No areas of discontinuous permafrost are indicated. The south-east extent of the Project in Labrador crosses lands that do not support permafrost (NRCan 2011, internet site).

Newfoundland

Newfoundland has undergone glacial events similar to those experienced in the south-eastern portion of Labrador. However, the pattern of ice dispersal is considered much more complex (Rogerson 1989). It is estimated that at least six dispersal centres existed during the most recent Late Wisconsin era event, some 12,000 years ago, rather than a single dome. Evidence gathered in the field from observing bedrock striations, indicates one dispersal centre existed on the Northern Peninsula centred along the Long Range Mountains, four were located throughout central Newfoundland, and a single dome was present over the Avalon Peninsula (Rogerson 1989).

The proposed transmission corridor across Newfoundland is underlain by a variety of unconsolidated soils which resulted from the last glaciation period (Figure 10.3.2-2). On the western side of the Northern Peninsula, along the coastline from the Strait of Belle Isle crossing southward to the Portland Creek area, surficial deposits generally comprise a thin veneer of marine-derived clays, sands and gravels; both were reworked during and after glaciation in response to isostatic rebound of the landmass. Rebound of the landmass on the Northern Peninsula has placed the limit of these marine deposits at elevations of up to 150 m above present-day sea level (Liverman and Taylor 1990). These deposits generally comprise silts, sands and gravels of varying proportions attaining thickness up to 15 m. Exposed bedrock outcrops or rock concealed by vegetation, are also common.

From Portland Creek toward the northern end of Sandy Lake, similar surficial deposits exist. The interior of the Northern Peninsula south-east of Portland Creek is dominated by exposed bedrock (particularly at the higher elevations of the Long Range Mountains), till veneer and outwash of glaciofluvial gravel and sand (Liverman and Taylor 1990). However, in the area referred to as the Deer Lake / Humber River Basin, they are overlain by unsubstantiated deposits of finer-grained marine-derived silts, clays and sands reaching thicknesses of up to 55 m, suggesting the existence of a large, post-glacial lake. The pattern of regional ice dispersal together with the presence of post-glacial deltas at elevations of up to 45 m above present-day sea level and weak, easily erodible bedrock on a regional scale would seem to support this theory (Batterson and Taylor 1990).

The transmission corridor crosses Newfoundland from the Deer Lake area, south-eastward to the Isthmus of the Avalon Peninsula. This expanse generally consists of a variety of glacial deposits including a till veneer <1.5 m thick, a till blanket which can reach a thickness of up to 7 m, hummocky terrain and glacio-fluvial deposits generally comprised of coarser gravels and sands with numerous to abundant cobbles and boulders (Liverman and Taylor 1990). Hummocky terrain does not exhibit a lineal footprint. They attain relief of 5 to 10 m and have gentle slopes. Bogs are common in the lower areas between hummocks. Common across insular Newfoundland are eskers and kames. Kames are defined as isolated mounds with moderate to steep slopes and relief of up to 20 m. Composition is generally similar to that of eskers. Exposed bedrock or bedrock with a thin cover of vegetation and rootmat is common in areas of higher elevation.

The Isthmus of the Avalon Peninsula is dominated by bedrock outcrop with little or no unconsolidated soil cover (King 1989). Terraces of moderately-sorted sands and gravels are common at elevations above present-day sea level of between 2 and 50 m. As previously mentioned, a single, smaller ice dome was present on the Avalon Peninsula during the last glacial event resulting in somewhat less pronounced features than those observed in insular Newfoundland. From the Isthmus of the Avalon Peninsula to Soldiers Pond, the transmission corridor traverses a variety of glacial depositional terrains, similar to those found in the insular portion of Newfoundland. The central portion of the Avalon Peninsula is dominated by hummocky terrain. Both west and east of this terrain, the geomorphology is defined predominantly by undifferentiated till greater than (>) 1.5 m in thickness, hummocks and glaciofluvial gravels and sands forming eskers and kames (Liverman and Taylor 1990). The presence of felsenmeer and erratic boulders are observed east of the central portion of the Avalon Peninsula and are particularly evident south of the town of Holyrood along the Trans-Canada Highway (Batterson and Taylor 2004). Felsenmeer is described as an occurrence of abundant angular-shaped boulders that originated from nearby bedrock, while erratics are more rounded and may have been transported over great distances by glaciers.

In Newfoundland, no discontinuous permafrost is indicated (NRCan 2011, internet site). Only isolated patches (0% to 10%) of permafrost are found in relation to the Long Range Mountains on the Northern Peninsula, extending from a point approximately 60 km north by north-east of Port au Choix to a point approximately 40 km north by north-west of Deer Lake (NRCan 2011, internet site). The remainder of Newfoundland is mapped as not supporting permafrost.

10.3.3 Vegetation

Vegetation contributes to humans and their natural environment. To understand vegetation, it is necessary to understand the fundamental role vegetation and vegetation communities (e.g., forests, wetlands) play in the functioning of natural ecosystems, including their contribution to ecosystem processes at a variety of spatial scales. Vegetation diversity and distribution play a key role in the regulation and flow of numerous ecosystem functions, such as soil and nutrient retention, flood protection, carbon-cycling and provision of habitat for a variety of organisms. Different species or communities of vegetation have varying influences upon ecosystem processes. Some species such as trees dominate ecosystem functioning because of their abundance. Meanwhile others such as listed species contribute to greater species richness, and therefore diversity, but contribute less to ecosystem function. Vegetation patterns are influenced by a range of natural (e.g., climate, substrate, terrain and water patterns) and anthropogenic factors.

10.3.3.1 Study Area

Existing baseline conditions for vegetation are presented in relation to the proposed transmission corridor from Central Labrador to the Island of Newfoundland's Avalon Peninsula and a surrounding 15 km wide Study Area, as well as considering the location of other Project-related components and activities. As shown in Figure 10.3.3-1, the Study Area is further divided into four geographic regions: (i) Central and Southeastern Labrador, (ii) Northern Peninsula, (iii) Central and Eastern Newfoundland; and (iv) Avalon Peninsula.

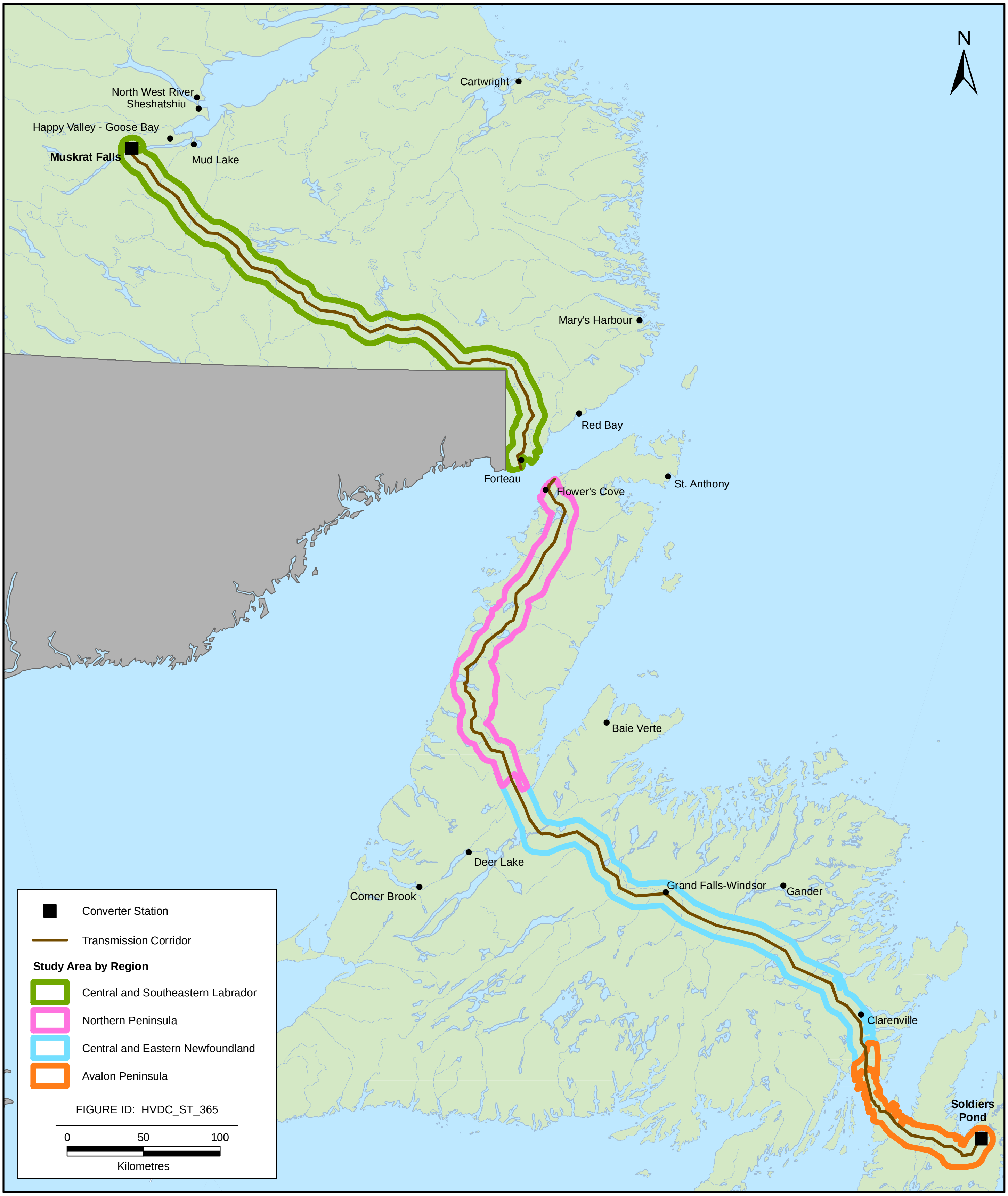


FIGURE 10.3.3-1

Vegetation Study Area and Transmission Corridor

10.3.3.2 Information Sources and Data Collection

The description of vegetation for the Project was compiled through literature reviews, existing data formats (e.g., satellite imagery, forestry vector data (for Newfoundland), air photos, digital elevation model data), and Project-specific field data collection. Specialists in the areas of botany and vegetation ecology reviewed relevant literature and data from NL government departments (Newfoundland and Labrador Department of Natural Resources (NLDNR), Newfoundland and Labrador Department of Environment and Conservation (NLDEC), federal government departments (Canadian Forestry Service, EC), and research organizations (Memorial University, Western Newfoundland Model Forest). The baseline vegetation description builds on information compiled through the following environmental component studies:

- the *Labrador – Island Transmission Link Ecological Land Classification* (Stantec 2010a);
- the *Labrador – Island Transmission Link Wetland Inventory and Classification* (Stantec 2010b);
- the *Labrador – Island Transmission Link Regionally Uncommon Plant Potential Mapping* (Stantec 2010c);
- the *Labrador – Island Transmission Link Timber Resources* (Stantec 2011a);
- the *Labrador – Island Transmission Link Vegetation Supplementary Report* (Stantec 2011b);
- the *Labrador – Island Transmission Link 2011 Listed and Regionally Uncommon Plant Survey: Strait of Belle Isle Cable Landing Sites and Shore Electrodes Sites Supplementary Report* (Stantec 2011c);
- the *Lower Churchill Hydroelectric Generation Project Environmental Impact Statement* (Nalcor 2009); and
- *the Lower Churchill Hydroelectric Generation Regional Ecological Land Classification and Generation Study Area Ecological Land Classification* (Minaskuat Inc. 2008a, b).

AEK has been collected from consultation initiatives with Aboriginal groups in the Study Area (a summary of all Aboriginal consultation initiatives conducted for the Project can be found in Chapter 7 of the EIS). Sources of AEK include, but are not limited to, land use surveys and interviews, reviews of existing published and unpublished literature and through the provision of information to Nalcor by an Aboriginal group or organization.

Local Ecological Knowledge (LEK) was collected from consultation initiatives with various communities (a summary of all consultation with public stakeholders can be found in Chapter 8 of the EIS) including Open Houses and correspondence. A general literature review and media search was also conducted.

Ecological Land Classification

A prerequisite to understanding the functioning ecosystems and determining the interactions with the Project is the inventory and classification of landscape structure and composition. Ecological Land Classification (ELC) and mapping involves the delineation of landscapes into ecologically distinct units. Characterization and delineation of terrain features and associated vegetation types traversed by the Study Area from Labrador to Newfoundland were undertaken during the 2008 ELC field program. The ELC describes the ecological mosaic of the Study Area, and is important in understanding other components of the existing environment, such as the identification and evaluation of wildlife habitat. The ELC is designed to be representative when considered in the context of land use planning applications at the site level, and to provide a complete spatial inventory of vegetation types / features to be used in broader environmental studies. The ELC was therefore developed for an environmental assessment and is at a scale deemed appropriate for that purpose, particularly when evaluating a project that includes a component that spans an area 60 m in width and 1,100 km in length.

A detailed description of the ELC is provided in the *Labrador - Island Transmission Link Ecological Land Classification* (Stantec 2010a). Results of the ELC were updated for the Labrador portion of the Study Area to accommodate changes in the corridor alignment, beginning at Muskrat Falls in the *Labrador - Island Transmission Link Vegetation Supplementary Report* (Stantec 2011b). Presented below is a brief summary.

The classification of vegetation into ecological units (or Habitat Types) for the Study Area was achieved using standard and validated methodology for describing ecological units (Marshall and Schutt 1999). Using an iterative approach, a variety of data formats including satellite imagery (Landsat 7 and Système Probatoire d'Observation de la Terre (SPOT) 5), forestry vector data (for Newfoundland), air photos, elevation and field survey data were compiled, forming the foundation of the ELC study. This combination of data formats resulted in a field survey program designed to support a systematic remote-sensing-based mapping program. The field program included surveys for 404 sites, of which 67 plots were in Labrador and 337 on the Island of Newfoundland. The combination of these two separate, but interrelated programs provided the best combination for the acquisition of ecological information relevant to the Project and mapping accuracy over the geographic area crossed by the Project.

The national ELC system described by Marshall and Schutt (1999) does not map units smaller than Ecodistricts. However, ELC systems often include smaller units such as Ecosections, with scales generally between 1:50,000 to 1:100,000, and Ecotypes, with approximate scales of 1:10,000 to 1:50,000. For this Project, the Study Area and the transmission corridor ELC maps delineate Habitat Type, which is not an ELC unit. Its classification is between the definitions of ELC Ecosections and ELC Ecotypes. The Habitat Type is sufficiently uniform in terms of ecological characteristics to reliably support the wildlife interpretations, wetland mapping, and listed plant and regionally uncommon plant potential mapping.

To examine the Study Area, the ELC was developed at a scale of 1:50,000 for an area of land 15 km wide and approximately 1,100 km long. The ELC identified, delineated and described 15 Vegetation / Habitat Types and several non-Habitat Types within the Study Area. The resultant maps were designed to provide a representation of the regional landscape. This information was subsequently used to quantify the type and area of ecological units or Habitat Types within the transmission corridor. This scaled approach to the classification of ecological units focused on the delineation of vegetation polygons within the transmission corridor where Project interactions will likely occur, while providing the regional context required for comparisons along the length of the Project. It also provides the requisite data to assess Project interactions and allow constraint mapping, avoidance and mitigation planning at the appropriate scales.

Wetlands

To develop a detailed inventory of wetlands within the transmission corridor, the following information sources were used (as described in Stantec 2010b):

- Ortho-corrected, high-resolution digital aerial photography (spatial resolution of 60 cm) at a scale of 1:30,000 for central Newfoundland was provided by the NLDEC – Lands Branch – Survey and Mapping Division (1999 to 2006).
- High-resolution SPOT 5 satellite imagery with a spatial resolution of 2.5 m and 5 m (2005 to 2008). The 2.5 m panchromatic (greyscale) imagery was coloured using SPOT 5, 10 m multispectral imagery and Landsat 7 imagery.
- National Topographic Map Series 1:50 000 scale topographic maps, provided by the Centre for Topographic Information, NRCan, Sherbrooke, Québec.
- Canadian Wetland Classification System (National Wetlands Working Group 1997).
- Classification of Peatland Vegetation in Atlantic Canada (Wells 1996).

A dedicated wetland inventory and classification study was carried out as part of the broader ELC. Characterization and delineation of wetland class and form was completed in accordance with the Canadian Wetland Classification System (National Wetlands Working Group 1997) and consistent with methodologies described in *Labrador - Island Transmission Link Wetland Inventory and Classification* (Stantec 2010b), in addition to the *Labrador - Island Transmission Link Vegetation Supplementary Report* (Stantec 2011b). This approach included the manual delineation and classification of wetlands with aerial and satellite photography, supplemented by detailed field surveys of representative wetlands along the length of the transmission corridor.

The wetland inventory was developed at a scale of 1:50,000 for the transmission corridor, with all visibly discernable wetlands manually delineated using a combination of Landsat and SPOT satellite imagery, aerial photography and wetlands identified on the National Topographic Map Service maps. Representative wetlands within the corridor were field surveyed (20 in Labrador and 68 in Newfoundland), classified by a wetland specialist and used as control sites to determine the "visual signature" of the various wetland classes found in each Ecoregion. Visual signature in this context refers to the photographic signatures of vegetation types or a reoccurring pattern of basic photo elements that have been identified by the interpreter for use in the identification of wetland class and form. With the incorporation of the high-resolution aerial photographs and satellite images into a geographic information system (GIS) platform, the wetland specialist was then able to magnify the surface features (e.g., vegetation colour signature, texture and distribution) of a particular area of interest. These visual signatures of the control wetland classes and forms on the high resolution spatial images were then used to interpret, delineate and classify the wetlands within the transmission corridor.

During the ELC delineation process, wetlands were mapped by algorithm based on the spectral signature / reflectance pattern in satellite images, and therefore provide an estimate of the wetland cover. This scale of mapping is intended to be used as a comparison of wetland area between regions, and in support of Project design and final routing for the transmission line right-of-way.

Wetlands outside of the transmission corridor but within the Study Area were delineated as part of the ELC study, but were not differentiated into wetland classes. The ELC study (Stantec 2010a) describes those wetlands in further detail. This scaled approach to wetland inventory focused efforts in the transmission corridor where Project interactions will likely occur, while also providing the regional context required for comparisons along the length of the Project.

Riparian Habitats

Information used to support the evaluation of riparian habitat included 1:50,000 hydrology data layers (NRCan 2010, internet site), protected public water supply area (PPWSA) mapping (NLDEC 2010a, internet site), scheduled salmon river mapping (Fisheries and Oceans Canada (DFO) 2009a, internet site) and the *Labrador – Island Transmission Link Freshwater Environment: Fish and Fish Habitat, Water Resources* (AMEC Earth and Environmental (AMEC) 2010a).

Baseline data for riparian habitat were calculated as the length of shoreline of watercourses and waterbodies in the transmission corridor by region. Shoreline class length was used to measure baseline riparian conditions, rather than the area of riparian habitat, because the functional and legislated width of riparian habitat is site-specific. The functional width of riparian zones varies according to factors such as stream size, topography, soil and subsoil characteristics, local catchment area and wildlife characteristics (Ilhardt et al. 2000). Riparian width may also be defined by regulations and / or guidelines designed to protect watercourses and waterbodies. Riparian widths (referred to therein as buffers) reported in guidelines and regulations in NL range from a minimum of 20 m for regular forestry operations (Newfoundland and Labrador Riparian Zone Working Group (NLRWG) 2007) to 150 m for activities within PPWSAs (NLDEC 1999, internet site). The linear nature of the Project infers that the proposed corridor will pass through several PPWSAs, scheduled salmon rivers (DFO 2009a, internet site), and several other rivers and watercourses, and therefore riparian width will differ greatly throughout the transmission corridor. Riparian shoreline length was therefore used to quantify baseline riparian habitat in the transmission corridor.

Due to the small scale required for the Project corridor mapping, riparian habitats were not delineated as separate units in the ELC study. Watercourses and waterbodies were identified using geospatially referenced, provincial hydrology mapping (NRCan 2010, internet site), PPWSA mapping (NLDEC 2010a, internet site) and scheduled salmon river mapping (DFO 2009a, internet site). Using GIS, the perimeters of mapped watercourses and waterbodies were defined as riparian habitat, and were divided into classes to allow identification by shoreline type and administrative unit (inside / outside PPWSAs). The calculated value of linear shoreline length includes neither the riparian areas of wetlands nor wetlands of riparian form, which are accounted for under wetlands.

Listed Plant Species

The management of plant species which are considered "listed" in Canada is a joint responsibility between provincial and federal governments. As such, the framework for the protection of listed species in NL includes overlapping legislation, regulations and guidelines. Within this overlapping management framework the status of plant species are evaluated at three levels:

- federally, under the *Species At Risk Act* (*SARA*) (Government of Canada 2003);
- provincially, under the Newfoundland and Labrador *Endangered Species Act* (*NLESA*) (GNL 2002a); and
- outside of the legislative framework, the status of listed plant species are also tracked on a provincial scale by the Atlantic Canada Conservation Data Centre (ACCDC) (ACCDC 2010, internet site).

The NatureServe Conservation Status Rank system is used to rank listed plant species across North America. Listed species are those species that occur in only a few localities and / or are represented by relatively few individuals. The system is consistent with conservation data centres across North America to facilitate tracking of listed plant occurrences and, where known, threat on global, national (federal) and subnational (provincial) levels. Conservation status ranks range from critically imperilled (N1) to demonstrably secure (N5). Status is assessed and documented at three distinct geographic scales: (i) global; (ii) national; and (iii) subnational (i.e., state / province / municipal) (Table 10.3.3-1). These status assessments are based on the best available information and consider a variety of factors, such as species abundance, distribution, population trends and threats (NatureServe 2009).

Table 10.3.3-1 NatureServe National and Subnational Conservation Status Ranks

Status	Rank	Definition
NX SX	Extinct or presumed extirpated	Not located despite intensive searches and no expectation of rediscovery
NH SH	Possibly extirpated	Possibly extinct or extirpated; known only from historical occurrences but still hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty
N1 S1	Critically imperilled	At very high risk of extinction due to extreme rarity (often five or fewer populations), steep declines or other factors, making the species especially susceptible to extirpation or extinction
N2 S2	Imperilled	At high risk of extinction due to very restricted range, few populations (often 20 or fewer), steep declines, or other factors
N3 S3	Vulnerable	At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors
N4 S4	Apparently secure	Uncommon but not rare, and usually widespread in the range. Some cause for long-term concern
N5 S5	Secure	Common or very common, and widespread and abundant. Not susceptible to extirpation or extinction under current conditions
NNR SNR	Unranked	National or subnational conservation status not yet assessed
NU SU	Unrankable	Currently unrankable due to lack of information or due to substantially conflicting information about status or trends

Note: N = national; S = subnational.

The description of the existing environment distinguishes between plant species that are protected (or listed) by federal or provincial endangered species legislation, and those that are considered regionally uncommon. To be considered "listed", a taxon would have to have a national rank of N1 or N2, and fall within the Endangered, Threatened or Special Concern status categories of Schedule 1 of *SARA* and / or provincially or Endangered, Threatened or Vulnerable by the *NLESA*. Consistent with the goal of preserving biodiversity, conservation efforts focus primarily on the protection of known locations or element occurrences of legally listed plant species and / or their habitats.

A detailed description of the data collection methods related to listed plant species (including their habitats) is provided in the *Labrador - Island Transmission Link Regionally Uncommon Plant Potential Mapping* (Stantec 2010c), the *Labrador - Island Transmission Link Vegetation Supplementary Report* (Stantec 2011b), and the *2011 Listed and Regionally Uncommon Plant Survey: Strait of Belle Isle Cable Landing Sites and Shore Electrodes Sites Supplementary Report* (Stantec 2011c). Presented below is a brief summary.

The evaluation of listed plants covers the same area as, and relies on, the same mapped Habitat Types described in the ELC (Stantec 2010a). Because the ELC was developed at a scale of 1:50,000 the evaluation of listed plants derived from it is also regional in scope. To examine the area(s) of the proposed transmission corridor occupied by known occurrences of listed plants with the highest probability of occurring, the Regionally Uncommon Plant Potential Mapping study focused on identification of those listed plant species or populations as determined by *SARA*, and spatial data contained within the *SARA* Public Registry (EC 2010k, internet site) and / or compiled within existing provincial endangered species databases (e.g., ACCDC). Data were collected at the appropriate scale for regional comparisons within the Study Area. This information was subsequently used to quantify the location and type of listed plants within the Study Area and, for analytical purposes, within the transmission corridor (Stantec 2010c).

In July 2011, a detailed plant survey was conducted of both cable landing sites, and the electrode sites for listed and regionally uncommon (rare) plant species. The purpose of the surveys was to identify known locations of listed plants and regionally uncommon plant species in the transmission corridor and in the vicinity of Project components (Stantec 2011c).

Regionally Uncommon Plant Species

The ACCDC manages plant species occurrence and distribution databases on behalf of the GNL (NLDEC 2010b, internet site). The ACCDC identifies and ranks all vascular plants known to occur in the province in consideration of the following factors: population size; number of occurrences; geographic distribution; trends in population; trends in distribution; threats to population; and threats to habitat. Each taxon is assigned a status and SRank (Table 10.3.3-2). The ACCDC ranks are specific to the geographic area (Labrador and / or the Island of Newfoundland) in which they occur, and as such, the rarity of a plant species is a matter of scale, meaning that a species may not be listed in Canada, but may be regionally uncommon in Labrador or Newfoundland. As a result, a species that occurs in both Labrador and in Newfoundland may have a different SRank for each geographic region.

Table 10.3.3-2 Definitions of the Atlantic Canada Conservation Data Centre Subnational Ratings

SRank	Definition
S1	Extremely rare throughout its range in the province (typically five or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in some locations (21 to 100 occurrences).
S4	Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the species is of long-term concern (e.g., watch list) (100+ occurrences).

Table 10.3.3-2 Definitions of the Atlantic Canada Conservation Data Centre Subnational Ratings (continued)

SRank	Definition
S5	Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (e.g., S1S2).
SH	Historical. Previously occurred in the province but may have been overlooked during the past 20-70 years. Presence is suspected and will likely be rediscovered; depending on species / community.
S?	Unranked. Not yet ranked. (The ? qualifies the character immediately preceding it in the S-rank).
SU	Unrankable: Possibly in peril, but status is uncertain - more information is needed.
SR	Reported but without persuasive documentation (e.g., misidentified specimen).
SE	Exotic / introduced species.
Hybrid	Hybrid of two similar species.

Regionally uncommon plant species are those species which occur in only a few localities in the province and / or are represented by relatively few individuals. Rarity is a relative concept and refers to how common or rare a species is relative to other species in a defined location as well as their pattern of distribution. The rarest species are those with small geographic ranges, few occurrences and few individuals in each occurrence. Regionally uncommon plant species include those ranked SH (historical), S1 (extremely rare) and S2 (rare) for the respective areas in which they occur and compiled within ACCDC "tracking lists", but not currently listed under *SARA* or the *NLESA*. It includes those species whose status are presently under review or for which there exists a lack of supported population information in NL. While S3 species are of concern from a provincial biodiversity perspective, they have not been included as their populations are considered less sensitive. In addition, all regionally uncommon plant species occurrences not previously reported from NL are considered rare.

There is also a provincial General Status assessment process that serves as a first alert tool to identify species in the province that are potentially at risk. Under this process, the populations of species that are native to the province are classified to be either "At Risk", "May be at Risk", "Sensitive", to human activities or natural events, "Secure", or "Undetermined" should there be insufficient data, information, or knowledge available to assess their status. Although species' listed under this process are not granted legislative protection the presence of species with populations considered to be At Risk, May be at Risk, or Sensitive is an issue of concern for provincial regulators.

The following approaches were used in the identification and mapping of regionally uncommon plant potential within the Study Area:

- an empirical approach, whereby sources (based on records acquired from the ACCDC) were used to identify Habitat Types reported to be associated with one or more regionally uncommon plant species; and
- a predictive modelling approach, whereby habitat requirements for regionally uncommon plants were compared with features of mapped ELC Habitat Types to rate these units for their plant potential.

This dual approach was necessary, as the Study Area is extensive and regionally uncommon plant surveys in these regions have been limited in extent and focus. In addition to the application of ratings for the Habitat Types, the known locations of regionally uncommon plant species within the Study Area (based on 2010 records in the ACCDC databases) were also used to rate the minimum potential of these specific areas to support regionally uncommon plant species.

Habitat requirements for identified regionally uncommon plant species were determined using regionally-specific sources where available, or alternatively, non-specific sources, unpublished literature and professional judgment. Plant species habitat requirements were compared to defined Habitat Types described and mapped during the preparation of the ELC. In those instances where appropriate habitat for regionally uncommon plants was present, that Habitat Type was identified as having elevated potential for regionally uncommon plant presence. Together, the comparison of habitat preference to mapped Habitat Types, as completed for the Project, depict currently known regionally uncommon plant areas and potential habitat based on habitat attributes. Regionally uncommon plant potential ratings are provided in Table 10.3.3-3.

Table 10.3.3-3 Regionally Uncommon Plant Potential Ratings

Location	Number of Regionally Uncommon Plant Species Required for Habitat Potential Ratings			Total Number of Regionally Uncommon Plant Species
	Low	Moderate	High	
Labrador	0 to 1	2 to 3	4+	20
Newfoundland	0 to 10	11 to 25	26+	122

Specific mapped Habitat Type and / or Non-Habitat Area polygons and the number of regionally uncommon plants associated with the ratings are:

- polygons with one regionally uncommon plant record were rated as having Moderate potential;
- polygons with 2 to 10 regionally uncommon plant records rated as having High potential; and
- polygons with more than 10 records rated as having Very High potential.

These individual polygons were rated independent of the Habitat Type and / or Non-Habitat Area ratings otherwise assigned to them. For example, although a Habitat Type may have had a low rating, specific areas of that Habitat Type may have 10 or more regionally uncommon plants previously identified by the ACCDC. As such, that specific Habitat Type polygon would receive a rating of Very High. Alternatively, aspects of some Non-Habitat Areas (e.g., open water), as identified in the ELC, may represent a specific habitat affinity for a narrow range of regionally uncommon plants, that would otherwise not have been assigned a regionally uncommon plant potential rating. In these instances, habitat preferences of regionally uncommon aquatic and / or semi-aquatic plant species focused on the littoral (close to the shore) zones of seashores, lakes or rivers; however, for modelling purposes, the entire Open Water Non-Habitat Area was rated, as appropriate.

Using these methods, all Habitat Types, Non-Habitat Areas and / or their sub-units were assigned a regionally uncommon plant potential rating. The regionally uncommon plant potential atlas (Stantec 2011b; Stantec 2010c) was based on the highest overall rating for each polygon.

Timber Resources

The *Labrador – Island Transmission Link Timber Resources Study* (Stantec 2011a, b) was completed to assess and describe the existing timber resources in the area of, and which may interact with, the proposed transmission corridor. In the context of this study, "timber resources" refers to those natural resources harvested from forests and woodlands of the province including natural ecosystems, managed plantations (cutblocks), or wood lots, which are used as a source for wood (e.g., industrial round wood (pulpwood), sawn timber, wood chips / pellets, or home-heating fuel). The study provides an analysis of the existing timber resource within the transmission corridor, as well as an estimate of likely quantities of timber that will be harvested as a result of Project activities.

A detailed inventory of timber resources (detailed methodology and results provided in Stantec 2011a, b) was conducted to evaluate and quantify the existing timber resources that will likely be removed as a result of the Project. The analysis utilized the best available, current NLDNR (Forest Resources Branch) forest inventory data (GNL 2010) incorporated into the Project's ELC, to describe the existing forest landbase and to quantify the type and gross merchantable volume (GMV) of timber resources within the proposed transmission corridor.

For Newfoundland, stock and stand tables (GNL 2010) were used to estimate the merchantable volume of timber for all softwood and hardwood stand types within the transmission corridor. Similar stock and stand tables were not available for relevant Forest Management Districts (FMDs) in Labrador, and as a result, volume tables were supplemented by yield curves to complete the analysis for Central and Southeastern Labrador, specifically as it relates to FMD 19C encompassing the String Bog (Eagle River Plateau) Ecoregion, and that of FMD 21 containing the Forteau Barrens Ecoregion of Labrador. For ease of analysis, GMV was calculated for the transmission corridor for: (i) each FMD crossed by the transmission corridor; (ii) each of the various subregions that comprise the Study Area (i.e., Central and Southeastern Labrador, Northern Peninsula, Central and Eastern Newfoundland, Avalon Peninsula); and (iii) for the Project as a whole.

10.3.3.3 Description of Vegetation

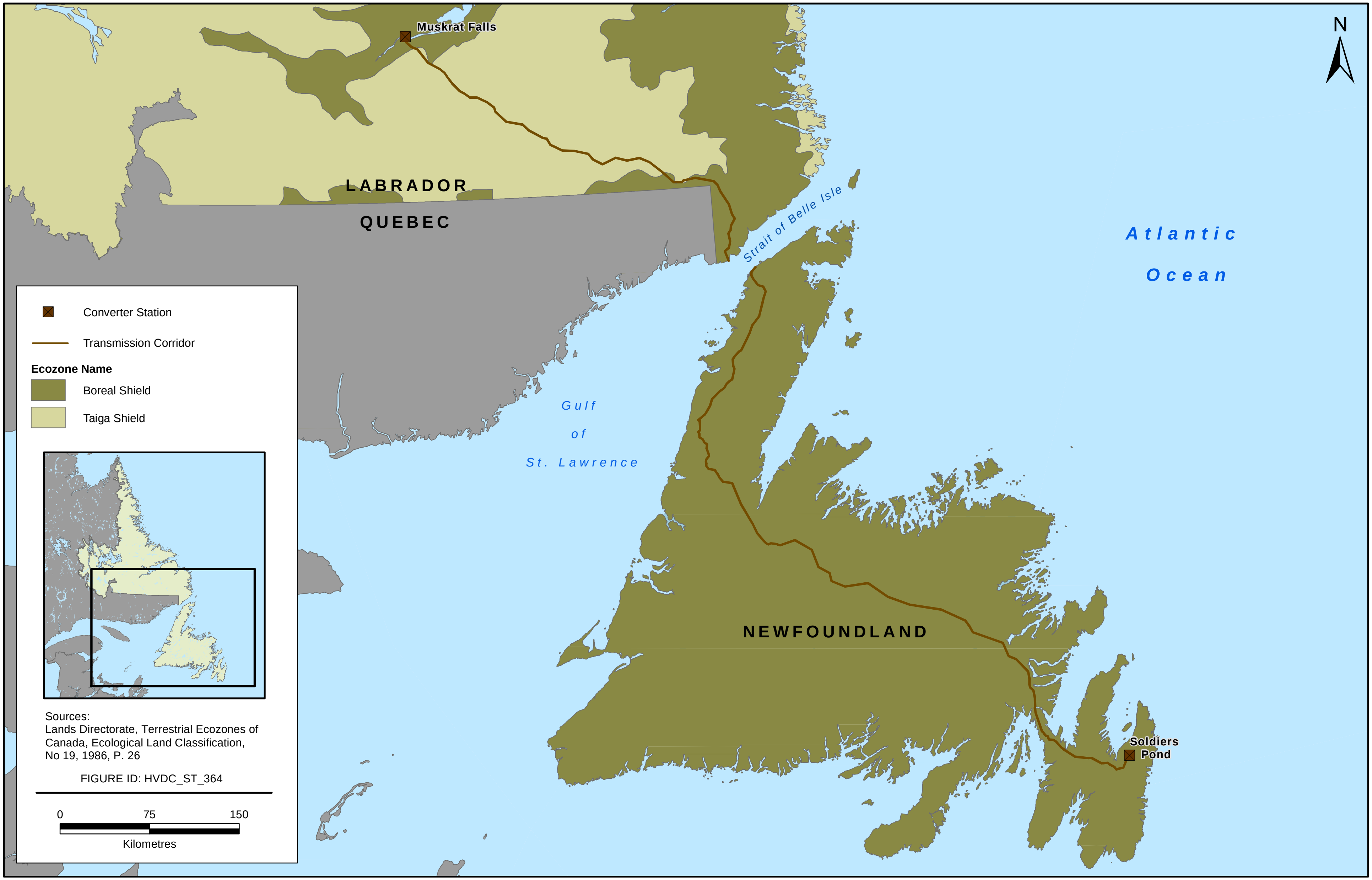
Vegetation in the Study Area represents a transition between Arctic ecosystems of the Taiga Shield Ecozone, typically associated with upland areas and higher elevations in the north, to the boreal forest ecosystems of the Boreal Shield Ecozone in the south. With the majority of the Study Area occurring within the Boreal Shield Ecozone of Southern Labrador and the Island of Newfoundland, undisturbed, upland coniferous forest vegetation is typically interspersed with wetlands. In Labrador, Aboriginal peoples are known to use select vegetation for food, medicine, fuel, shelter and other cultural purposes. Abundance and health of vegetation in the Study Area is presently influenced by factors such as forest fire, insect infestations, disease and commercial forest harvesting activities.

Ecological Land Classification

The national ecological framework for Canada is a nested hierarchy that describes regional ecological units at multiple scales, in which larger ecological units encompass successively smaller ones. At the top of the hierarchy, Ecozones are defined on the basis of generalized characteristics and global and continental climate. There are 15 Ecozones (NRCan 2007, internet site) delineated for Canada. The transmission corridor crosses two of these: Boreal Shield Ecozone and Taiga Shield Ecozone (Figure 10.3.3-2).

These two Ecozones are further divided into a number of Ecoregions. Ecoregions are smaller land units within Ecozones having distinctive, recurring patterns of vegetation and soil determined and controlled by local climate and geology. Ecoregions also differ from each other in their combinations of plant communities, landscapes, geology and other features (Parks and National Areas Division 2008, internet site; Marshall and Schutt 1999).

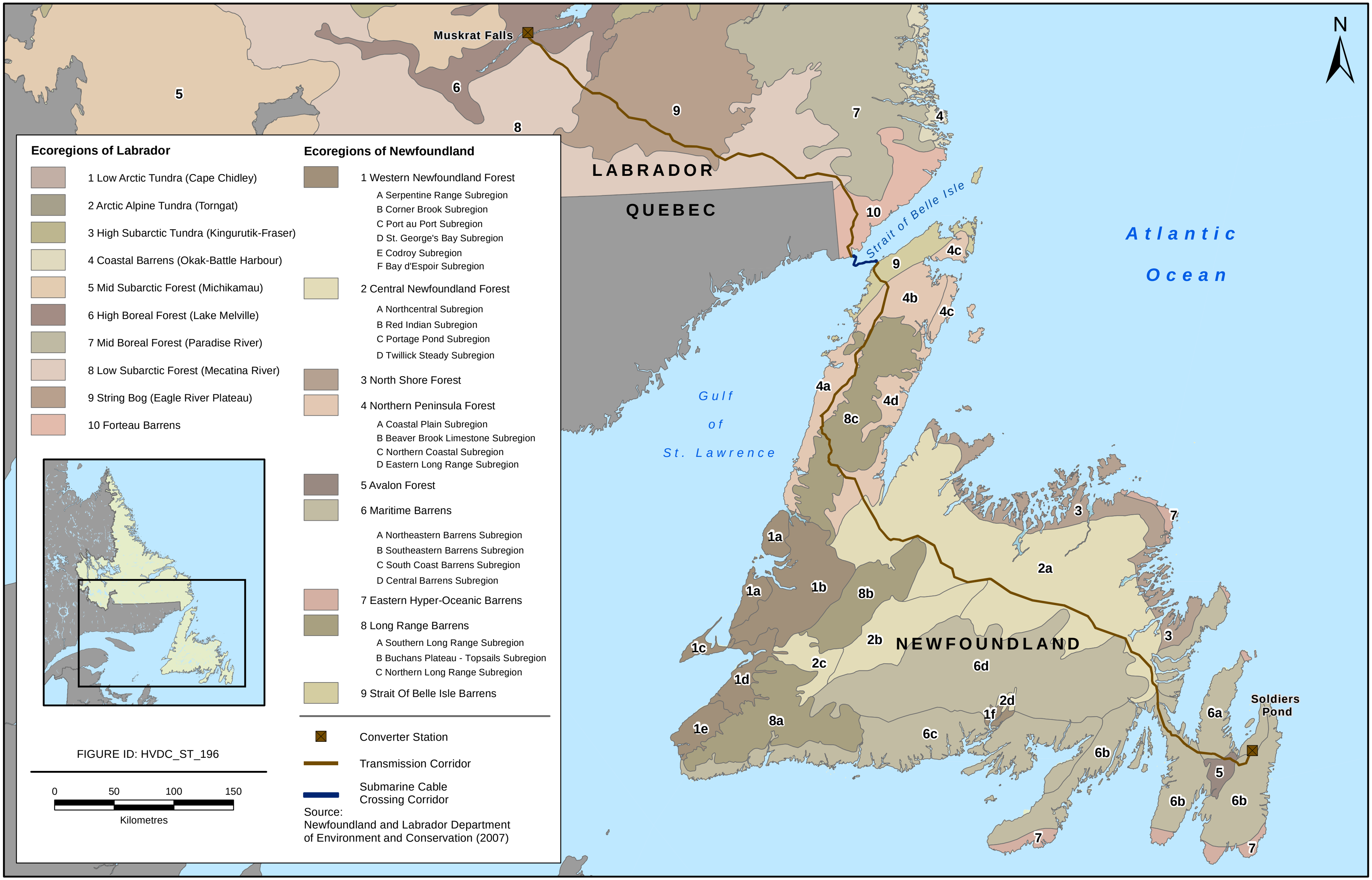
There are 19 Ecoregions within the province, nine in Newfoundland (Damman 1983) and 10 in Labrador (Meades 1990). The transmission corridor passes through 10 of these Ecoregions, four of which occur in Labrador and six in Newfoundland (Figure 10.3.3-3). A summary of the amount of each Ecoregion crossed by the transmission corridor is provided in Table 10.3.3-4. A description of the Ecoregions and relevant subregions is provided in the *Labrador - Island Transmission Link Ecological Land Classification* (Stantec 2010a).



nalcor energy

FIGURE 10.3.3-2

Transmission Corridor and Associated Ecozones of Newfoundland and Labrador



nalcor energy

FIGURE 10.3.3-3

Transmission Corridor and Associated Ecoregions of Newfoundland and Labrador

Table 10.3.3-4 Summary of Ecoregions Crossed by the Transmission Corridor

Ecoregion	Total Area within the Transmission Corridor (km^2)	Percent of the Transmission Corridor (%)
Labrador		
High Boreal Forest (Lake Melville)	22	1
Low Subarctic Forest (Mecatina River)	348	16
String Bog (Eagle River Plateau)	267	12
Forteau Barrens	133	6
Subtotal (Labrador)	*770*	*36*
Newfoundland		
Strait of Belle Isle Barrens	44	2
Northern Peninsula Forest	288	13
Long Range Barrens	153	7
Central Newfoundland Forest	641	30
Maritime Barrens	238	11
Avalon Forest	22	1
Subtotal (Newfoundland)	*1,386*	*64*
Total (Newfoundland and Labrador)[a]	**2,156**	**100**

[a] Rounding errors <1% may occur in final total.

Fifteen ELC Habitat Types (as defined by plant species presence and abundance) were identified within Ecoregions crossed by the transmission corridor. Nine Habitat Types were identified for Labrador (Table 10.3.3-5; Figure 10.3.3-4 and Figure 10.3.3-5) and 10 Habitat Types were identified for Newfoundland (Table 10.3.3-6; Figure 10.3.3-6 and Figure 10.3.3-7, Table 10.3.4-7; Figure 10.3.3-8 and Figure 10.3.3-9, and Table 10.3.3-8; Figure 10.3.3-10 and Figure 10.3.3-11). Burn, Conifer Forest, Conifer Scrub, Mixedwood Forest, Open Conifer Forest and Wetland ELC Habitat Types are common to both Labrador and Newfoundland. Detailed descriptions of ELC Habitat Types and Non-Habitat Areas and a map atlas (presented at a reduced scale of 1:75,000) depicting all Habitat Types within the Study Area are provided in the *Labrador - Island Transmission Link Ecological Land Classification* (Stantec 2011b; Stantec 2010a).

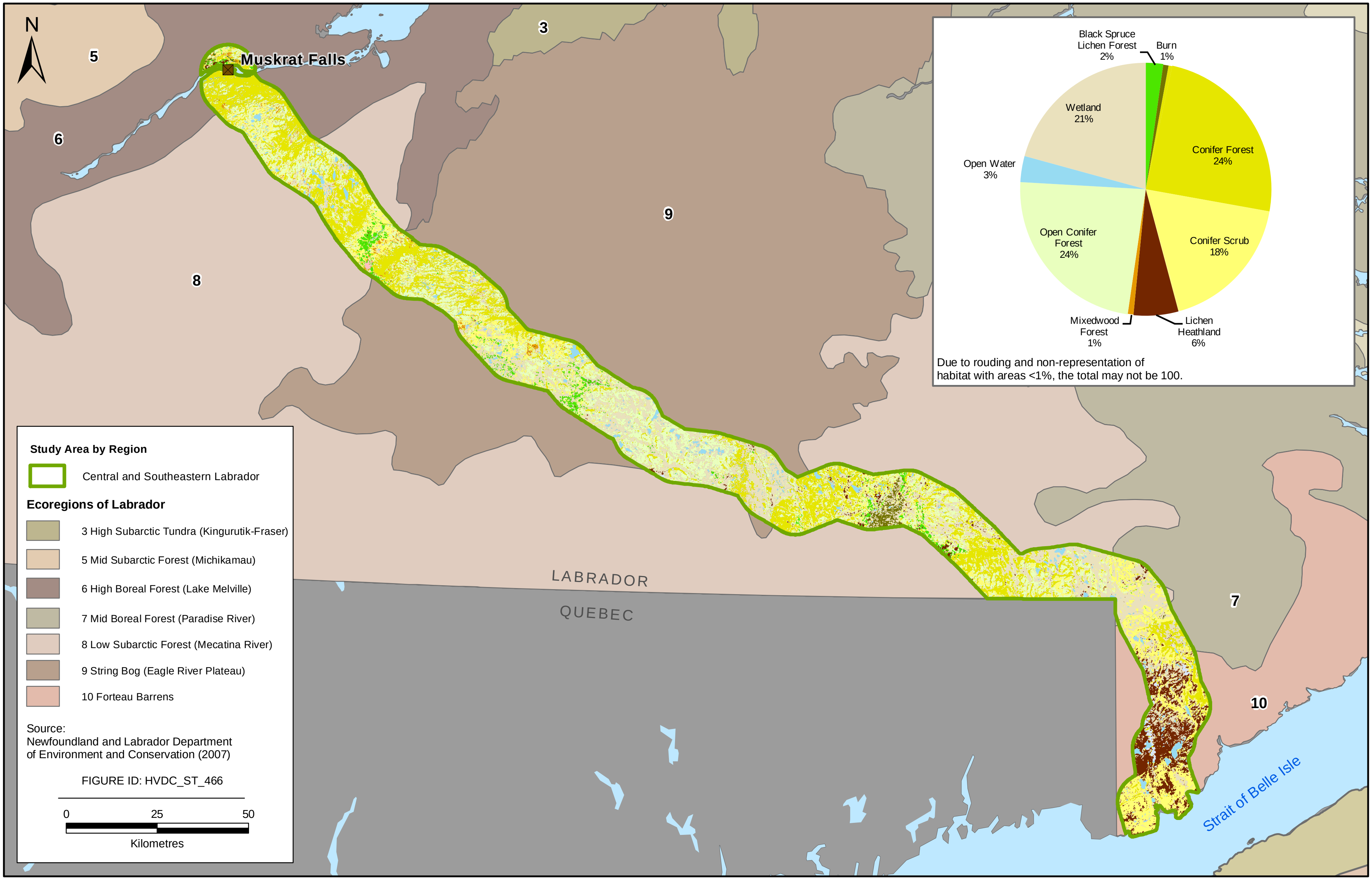
The transmission corridor within Central and Southeastern Labrador comprises an area of 770 square kilometres (km^2), of which 45% occurs within the Low Subarctic Forest (Mecatina River) Ecoregion (Table 10.3.3-5). The most common Habitat Types occurring in this region are Open Conifer Forest, Conifer Forest, Conifer Scrub and Wetland, each occupying a range of 19% to 26% of the total area in this region. Uncommon Habitat Types (i.e., those occupying 5% or less of a region) are Black Spruce Lichen Forest, Burn, Hardwood Forest and Mixedwood Forest.

Approximately 59% of the transmission corridor in the Northern Peninsula occurs within the Northern Peninsula Forest Ecoregion and 32% within the Long Range Barrens Ecoregion. The total area is 484 km^2. The dominant habitat types include Conifer Forest and Scrub / Heathland / Wetland Complex which occupy a range of 28 to 22% of the total areas in this region, respectively, are shown in Table 10.3.3-6. Alpine Vegetated, Conifer Scrub, Kalmia Lichen / Heathland and Rocky Barrens are considered as uncommon Habitat Types for the Northern Peninsula.

Table 10.3.3-5 Habitat Types and Non-Habitat Areas Crossed by the Transmission Corridor by Ecoregion in Central and Southeastern Labrador

Ecoregion	Habitat Types									Non-Habitat Areas			Total Area (km²) (Percent of Total - %)
	Black Spruce Lichen Forest	Burn	Conifer Forest	Conifer Scrub	Hardwood Forest	Lichen Heathland	Mixedwood Forest	Open Conifer Forest	Wetland	Cloud / Shadow	Exposed Earth / Anthropogenic / Cutblock	Open Water	
Within the Transmission Corridor													
High Boreal Forest (Lake Melville) (km^2)	0	0	18	<1	0	0	0	4	<1	0	0	<1	22 (3)
Low Subarctic Forest (Mecatina River) (km^2)	10	5	123	54	0	3	3	84	61	0	<1	6	348 (45)
String Bog (Eagle River Plateau) (km^2)	5	0	47	43	0	<1	<1	105	63	0	0	4	267 (35)
Forteau Barrens (km^2)	0	0	10	57	0	40	0	2	21	<1	0	2	133 (17)
Total Area of Central and Southeastern Labrador Transmission Corridor (km^2)	15	5	197	155	0	44	3	194	145	<1	<1	12	770 (100)
Percent of Central and Southeastern Labrador (Transmission Corridor)	**2**	**<1**	**26**	**20**	**0**	**6**	**<1**	**25**	**19**	**<1**	**<1**	**2**	**100**
Percent of Entire Transmission Corridor (Newfoundland and Labrador)	**<1**	**<1**	**9**	**7**	**0**	**2**	**<1**	**9**	**7**	**0**	**0**	**<1**	**36**

Note: Rounding errors <1% may occur.



nalcor energy

FIGURE 10.3.3-4

Habitat Types and Non-Habitat Areas within the Study Area for Central and Southeastern Labrador